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Effects of pork production technique on optimum farm resource use

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EFFECTS OF PORK PRODUCTION TECHNIQUE ON OPTIMUM FARM RESOURCE USE

by

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CHAPTER I: INTRODUCTION

Cornbelt farmers have been confronted with three particular problems in recent years. They are: (1) relatively low incomes because of low product prices and the cost-price squeeze resulting from economic growth, (2) pressure for larger enterprises and farms due to the advance of technology and mechanization, and (3) development of contract or integrated farming, which some fear may cause the center of pork production to shift to the Southeast. As a result, many have been concerned with methods of expanding their farm businesses. Since sale of hogs is a main income source of the Cornbelt, farmers have been especially interested in the profit possibilities from improving the hog enterprise.

Interests are of two sorts: in rearranging the hog enterprise to allow larger volume and lower costs from existing resources, and in adopting the production technologies which appear to be the basis for contract hog raising. Many are concerned as to whether or not a farmer can adopt these technologies and gain more profit, or gain the essential advantages of integration without entering a contract.

This thesis is directed toward answering some questions in this area. It is concerned particularly with the profit potential of alternative hog production technologies in relation to the more conventional systems and to the overall organization of farm resources. Alternative pork production

innovations considered include larger scale units, multiple farrowing, and confinement raising.

The Nature of the Hog Enterprise

The hog enterprise can be expanded quite readily. Production requires less than a year, and a relatively small capital investment in proportion to sales is needed. Hence, optimum scale is of practical interest to all farmers. It is especially important to young operators who are limited in capital and have low incomes. They generally have underemployed labor which can be used.

Volume can be increased by expanding the conventional system or by adopting a multiple farrowing plan. In multiple systems, farrowings are spread over four or six different months. This procedure distributes fixed cost and investment over a larger output by using facilities more fully. Labor requirements are more evenly distributed over the year than with conventional systems, but quality of the labor may need to be higher. Both methods of expansion require additional amounts of capital and labor. However, while conventional one and two litter systems use rotated pasture extensively, multiple farrowing has become associated with the confinement-on-concrete technology. Some land is released for grain production, but new management problems arise with confinement raising and increased intensity. In some cases, average price

received may also be higher.

Fitting Hog Production to the Farm Situation

The choice of hog raising system should depend not alone on evaluating these considerations to determine the least cost or highest return method for the enterprise. As Carroll and Krider (2, p. 1) emphasize, the choice cannot be made apart from the best use of the resources on the entire farm:

> The entire swine enterprise must be organized and operated in such a manner that will supplement--certainly not conflict with--the efficient operation of the other farm enterprises . . . a successful farm is the result of the harmonious operation of a number of different enterprises operating as nearly perfectly as their relations to one another will permit . . . principles of good farm management dictate that each enterprise must be considered not from the standpoint of its own perfection and isolated functioning, but from the standpoint of what its contribution can be to the farm as a whole as it operates under the influence of other necessary enterprises.

No one system is best in all cases. Variations in quantities of physical resources available, in managerial ability of the operator, and in other production alternatives available influence the selection of a most profitable system. However, a number of typical farm situations can be described within a given area. Optimum plans under these conditions provide benchmarks which apply over a determinable range of conditions.

These plans can be used to guide suggestions for profit increasing adjustments in individual farm situations. They can also suggest answers to some of the questions posed on vertical integration. This study is directed toward developing some benchmarks for farms considering expanded swine production.

CHAPTER II: OBJECTIVES

The overall purpose of this study is to examine the place of various hog systems in 160-acre farm businesses which have low incomes and resource underemployment problems. Specific objectives are:

1. To determine whether, and by how much, income might be increased by use of more recent suggested hog production systems, or by expansion of conventional systems.
2. To determine whether these systems are best adapted to particular farm situations, represented by variations in soils, capital availability, and managerial ability of the operator.
3. To estimate the effect which adopting these systems has on optimum farm resource use.
4. To estimate the effect of increasing capital availability on the adoption of suggested hog systems.
5. To estimate the effect of improved management on income, resource use, and adoption of suggested hog systems.

CHAPTER III: FARM SITUATIONS STUDIED

One hypothesis underlying this study is that more recent pork production methods are not equally adapted to all farm situations. They may be better adapted to farms with surplus capital, with underemployed labor, or with a poor manager, for example. Hence, in order to examine these possibilities, several different farm situations were studied.

Resource Supplies

The analysis was conducted for 160 acre owner operated farms in two contrasting soil areas--Clarion-Webster, the level and productive soils of north-central Iowa, and Shelby-Grundy-Haig, the rolling and hilly soils of southern Iowa where a large proportion of the land is in permanent pasture.* Clarion and Webster are farmed together, but the Shelby, Grundy, and Haig soils must be divided into three classes on the basis of slope and cropped differently.** Land use for each area is summarized in Table 1.

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*For soil type descriptions, see: Simonson et al. (14, pp. 38-43, 82-89).

**Shelby-Grundy-Haig classes are as follows: Class I is 0-1% slope, mainly Haig Silt Loam. Class II is 2-5% slope, primarily Grundy Silt Loam. Class III is 4-14% slope, mostly Shelby Loam. All land over 14% slope is in permanent pasture.

Table 1. Land use relationships[a]

Use	Clarion-Webster[b]	Shelby-Grundy-Haig[c]
Cultivated	93.9 %	69.6 %
Class I		(10.1)
Class II		(42.9)
Class III		(16.6)
Permanent pasture	3.3 %	27.2 %
Woodland and farmstead	2.8 %	3.2 %

[a]L. E. Tyler, Ames, Iowa. Data from statistical soil surveys. Private communication. 1958.

[b]Clarion-Webster percentages were calculated from data for Webster, Humboldt, and Pocahantas Counties.

[c]Shelby-Grundy-Haig data was for Decatur, Clarke, and Union Counties.

In each soil area, plans were computed at three levels of management. For purposes of this study, an operator is rated in the same management category--low level, average, or superior--for all crop and livestock enterprises he produces. Production practices assumed at each level of management are summarized in Appendix A. Effects of the variations in practices are reflected in the basic input-output data used.

The optimum plan may depend on the amount of capital available. Hence, plans have been computed assuming several different operating capital supplies. These represent amounts

Table 2. Available building space[a]

Area	Hog units	Cattle units
Clarion-Webster	15	18
Shelby-Grundy-Haig	0	18

[a]Cattle building space can also be used for hogs, but hog space is specialized. One unit equals space for one sow and litter or for a beef cow and calf, or about 50 square feet.

available to use on any of the productive enterprises to be described later. Lower levels may be representative of conditions facing young farmers and higher levels of more experienced operators. A working amount of farm machinery is assumed (see Table 11), except that a custom operator is hired to harvest small grains and soybeans. Any specialized livestock equipment must be purchased.

Hay and grain storage facilities are adequate. Available building space for hogs and cattle is summarized in Table 2. Clarion-Webster farms have 15 units of specialized hog buildings and 18 units of space that can be used for cattle or hogs. The Shelby-Grundy-Haig farms have 18 units which can be used for either class of livestock. A unit is space for one sow and litter or for one beef cow and calf.

Rotation meadow is harvested for hay only if it is to be fed. Labor and other harvest costs are charged to cattle

Table 3. Direct labor available

Period	Working days	Hours/day	Total hours
Dec.-Jan.-Feb.	78	8	624
March-April	52	8½	442
May-June	52	10	520
July-August	52	13	676
Sept.-Oct.-Nov.	78	8½	663

consuming the hay. Unused rotation forage and unused permanent pasture are left idle, and hay cannot be bought or sold. Oats and corn are handled as feed grains, which can be purchased, sold, or fed to livestock.

Labor requirements are stated as direct labor input. Direct labor includes "time spent in growing, harvesting, storing, and selling crops or time spent in feeding, caring for, and marketing livestock and livestock products (12, p. 35). The family labor supply is restricted to allow for indirect labor requirements of the farm.

Many farm operations using direct labor can be postponed a short while, yet must be done during a certain season. Hence, labor restrictions are made for seasonal groupings as follows: December-January-February, March-April, May-June, July-August, and September-October-November. Supplies are summarized in

Table 3. In addition, hourly labor can be hired for $1.10 per hour during May and June.

Enterprises Used

The basic enterprises considered in this study include eight rotation-fertilization rate combinations, two beef cow systems, four feeder cattle systems, and eight hog systems. Although numerous other enterprises and techniques are available to farmers in production planning, only those which are considered feasible have been used. All enterprises compete freely for the use of resources.

Crop enterprises

The crop rotations used in this study vary with the land class. It is assumed that terraces and contour cultivation will be used where needed and that drainage is adequate. Yield levels assume average weather conditions and vary with management level.

In the Clarion-Webster area, corn-corn-oats-meadow (CCOM), corn-soybeans-corn-oats-meadow (CSbCOM), and corn-corn-soybeans (CCSb) are feasible rotations. These are also the rotations considered for the Class I soil in the Shelby-Grundy-Haig area. For Class II Shelby-Grundy-Haig, the rotations are corn-corn-oats-meadow (CCOM), corn-soybeans-corn-oats-meadow (CSbCOM), corn-corn-oats-meadow-meadow (CCOMM), and corn-oats-meadow (COM); for Class III they are corn-oats-

Table 4. Clarion-Webster Association Soils: resource requirements, returns, and physical output per acre of selected cropping activities at three management levels[a]

Management	Item	$CCOM_{0or1}$	$CCOM_2$	$CSbCOM_{0or1}$	$CSbCOM_2$	$CCSb_{0or1}$	$CCSb_2$
Low level							
	Labor (man hours)						
	Dec.-Jan.-Feb.	0.08	0.08	0.08	0.08	0.03	0.03
	March-April	1.12	1.14	1.40	1.42	1.81	1.81
	May-June	1.76	1.81	1.88	1.94	3.06	3.16
	July-August	0.22	0.22	0.21	0.21	0.30	0.30
	Sept.-Oct.-Nov.	1.21	1.21	0.97	0.97	1.71	1.71
	Operating capital[b] ($)	7.12	13.08	7.21	12.54	7.83	16.65
	Net return ($)	29.84	32.10	31.97	33.11	41.43	50.14
	Feed grain produced (bu.)	30.50	37.25	24.40	29.00	28.33	41.67
	Hay produced (tons)	0.45	0.50	0.36	0.44	0.00	0.00
Average							
	Labor (man hours)						
	Dec.-Jan.-Feb.	0.08	0.08	0.08	0.08	0.03	0.03
	March-April	1.10	1.12	1.42	1.44	1.75	1.75
	May-June	1.72	1.77	1.88	1.94	3.06	3.16
	July-August	0.22	0.22	0.21	0.21	0.30	0.30
	Sept.-Oct.-Nov.	1.18	1.18	0.95	0.95	1.67	1.67
	Operating capital[b] ($)	7.48	13.47	7.56	12.91	8.55	17.38
	Net return ($)	32.05	36.02	34.81	38.07	43.70	53.94
	Feed grain produced (bu.)	32.62	40.81	26.45	32.05	30.50	44.17
	Hay produced (tons)	0.575	0.675	0.46	0.56	0.00	0.00
Superior							
	Labor (man hours)						
	Dec.-Jan.-Feb.	0.09	0.09	0.08	0.08	0.03	0.03
	March-April	1.20	1.20	1.55	1.55	1.82	1.82
	May-June	1.79	1.79	2.02	2.02	3.23	3.23
	July-August	0.22	0.22	0.22	0.22	0.30	0.30
	Sept.-Oct.-Nov.	1.18	1.18	0.98	0.98	1.68	1.68
	Operating capital[b] ($)	11.53	14.50	11.09	13.73	14.44	19.27
	Net return ($)	36.40	39.30	40.55	42.57	53.26	56.57
	Feed grain produced (bu.)	39.55	44.38	31.94	35.10	40.77	46.67
	Hay produced (tons)	0.75	0.85	0.60	0.68	0.00	0.00

[a]Subscript number (0) on rotation symbol means no fertilization; it applies to low level and average management. Subscript (1) refers to intermediate fertilization rate used by superior managers. Subscript (2) refers to high rate of fertilization used at all three levels of management.

[b]Operating capital includes production cost, spraying, shelling, seed and fertilizer.

Table 5. Shelby-Grundy-Haig Association Soils, Class I soil[a]: resource requirements, returns, and physical output per acre of selected cropping activities at three management levels[b] on Shelby etc

Management	Item	$CCSb_{0or1}$	$CCSb_2$	$CCOM_{0or1}$	$CCOM_2$	$CSbCOM_{0or1}$	$CSbCOM_2$
Low level							
BELOW AVERAGE	Labor (man hours)						
	Dec.-Jan.-Feb.	0.03	0.03	0.08	0.08	0.08	0.08
	March-April	1.81	1.81	1.12	1.14	1.40	1.42
	May-June	3.06	3.16	1.76	1.81	1.88	1.94
	July-August	0.30	0.30	0.22	0.22	0.21	0.21
	Sept.-Oct.-Nov.	1.71	1.71	1.21	1.21	0.97	0.97
	Operating capital[c] ($)	7.35	14.31	7.03	11.76	7.14	11.13
	Net return ($)	34.42	40.15	24.77	25.33	28.37	29.53
	Feed grain produced (bu.)	24.00	32.67	26.25	30.62	21.00	24.50
	Hay produced (tons)	0.00	0.00	0.50	0.58	0.40	0.46
Average							
	Labor (man hours)						
	Dec.-Jan.-Feb.	0.03	0.03	0.08	0.08	0.08	0.08
	March-April	1.75	1.75	1.10	1.12	1.42	1.44
	May-June	3.06	3.16	1.72	1.77	1.88	1.94
	July-August	0.30	0.30	0.22	0.22	0.21	0.21
	Sept.-Oct.-Nov.	1.67	1.67	1.18	1.18	0.95	0.95
	Operating capital[c] ($)	8.40	15.85	7.38	12.14	7.48	11.49
	Net return ($)	35.89	44.90	26.32	28.52	30.24	32.82
	Feed grain produced (bu.)	24.50	36.00	27.81	33.56	22.25	26.75
	Hay produced (tons)	0.00	0.00	0.52	0.61	0.42	0.49
Superior							
ABOVE AVERAGE	Labor (man hours)						
	Dec.-Jan.-Feb.	0.03	0.03	0.09	0.09	0.08	0.08
	March-April	1.82	1.82	1.20	1.20	1.55	1.55
	May-June	3.23	3.23	1.79	1.79	2.02	2.02
	July-August	0.30	0.30	0.22	0.22	0.22	0.22
	Sept.-Oct.-Nov.	1.68	1.68	1.18	1.18	0.98	0.98
	Operating capital[c]($)	13.59	17.27	10.81	13.13	10.34	12.30
	Net return ($)	45.26	49.77	29.88	31.09	34.57	35.64
	Feed grain produced (bu.)	33.40	39.33	33.59	36.50	26.79	29.00
	Hay produced (tons)	0.00	0.00	0.58	0.65	0.46	0.52

[a]Soil classes are described in the section on land restrictions in the text.

[b]Subscript number (0) on rotation symbol means no fertilization; it applies to low level and average management. Subscript (1) refers to intermediate fertilization rate used by superior managers. Subscript (2) refers to high rate of fertilization used at all three levels of management.

[c]Operating capital includes production cost, spraying, shelling, seed, and fertilizer.

Table 6. Shelby-Grundy-Haig Association Soils, Class II soil[a]: resource requirements, returns, and physical output per acre of selected cropping activities at three management levels[b]

Management Item	$CCOM_{0or1}$	$CCOM_2$	$CSbCOM_{0or1}$	$CSbCOM_2$	$CCOMM_{0or1}$	$CCOMM_2$	COM_{0or1}	COM_2
Low level								
Labor (man hours)								
Dec.-Jan.-Feb.	0.08	0.08	0.08	0.08	0.07	0.07	0.10	0.10
March-April	1.12	1.14	1.40	1.42	0.90	0.92	1.05	1.08
May-June	1.76	1.81	1.88	1.94	1.41	1.45	1.21	1.24
July-August	0.22	0.22	0.21	0.21	0.18	0.18	0.17	0.17
Sept.-Oct.-Nov.	1.21	1.21	0.97	0.97	0.97	0.97	0.76	0.76
Operating capital[c] ($)	7.01	11.80	7.12	11.16	5.65	9.08	6.98	9.98
Net return ($)	23.59	25.30	25.60	28.14	20.99	20.60	18.62	19.49
Feed grain produced (bu.)	25.25	30.62	20.20	24.50	22.00	24.50	21.00	24.17
Hay produced (tons)	0.50	0.58	0.40	0.46	0.70	0.82	0.67	0.77
Average								
Labor (man hours)								
Dec.-Jan.-Feb.	0.08	0.08	0.08	0.08	0.07	0.07	0.10	0.10
March-April	1.10	1.12	1.42	1.44	0.88	0.90	1.04	1.07
May-June	1.72	1.77	1.88	1.94	1.38	1.42	1.18	1.21
July-August	0.22	0.22	0.21	0.21	0.17	0.17	0.17	0.17
Sept.-Oct.-Nov.	1.18	1.18	0.95	0.95	0.95	0.95	0.78	0.78
Operating capital[c] ($)	7.36	12.18	7.46	11.52	5.94	9.39	7.17	10.19
Net return ($)	25.59	28.63	28.51	32.34	23.25	23.96	20.76	22.22
Feed grain produced (bu.)	27.19	33.69	21.75	26.95	24.10	27.55	22.92	26.58
Hay produced (tons)	0.52	0.61	0.42	0.49	0.81	0.95	0.70	0.82
Superior								
Labor (man hours)								
Dec.-Jan.-Feb.	0.09	0.09	0.08	0.08	0.08	0.08	0.11	0.11
March-April	1.20	1.20	1.55	1.55	0.96	0.96	1.17	1.17
May-June	1.79	1.79	2.02	2.02	1.44	1.44	1.27	1.27
July-August	0.22	0.22	0.22	0.22	0.18	0.18	0.18	0.18
Sept.-Oct.-Nov.	1.18	1.18	0.98	0.98	0.95	0.95	0.77	0.77
Operating capital[c] ($)	10.79	13.20	10.36	12.34	8.52	10.23	9.34	10.82
Net return ($)	29.93	31.32	34.41	36.10	26.34	26.83	23.60	24.54
Feed grain produced (bu.)	33.61	36.75	26.89	29.40	28.70	30.60	27.02	29.00
Hay produced (tons)	0.58	0.65	0.46	0.52	0.96	1.08	0.77	0.87

[a]Soil classes are described in the section on land restrictions in the text.

[b]Subscript number (0) on rotation symbol means no fertilization; it applies to low level and average management. Subscript (1) refers to intermediate fertilization rate used by superior managers. Subscript (2) refers to high rate of fertilization used at all three levels of management.

[c]Operating capital includes production cost, spraying, shelling, seed, and fertilizer.

Table 7. Shelby-Grundy-Haig Association Soils, Class III soil[a]: resource requirements, returns, and physical output per acre of selected cropping activities at three management levels[b]

Management	Item	COM_{0or1}	COM_2	$COMM_{0or1}$	$COMM_2$	$CCOMM_{0or1}$	$CCOMM_2$
Low level							
BELOW AVERAGE	Labor (man hours)						
	Dec.-Jan.-Feb.	0.10	0.10	0.08	0.08	0.07	0.07
	March-April	1.05	1.08	0.80	0.82	0.90	0.92
	May-June	1.21	1.24	0.90	0.92	1.41	1.45
	July-August	0.17	0.17	0.13	0.13	0.18	0.18
	Sept.-Oct.-Nov.	0.76	0.76	0.57	0.57	0.97	0.97
	Operating capital[c] ($)	6.58	13.65	4.93	10.67	5.46	12.93
	Net return ($)	7.46	6.66	6.79	4.55	9.98	6.63
	Feed grain produced (bu.)	10.64	16.60	9.60	12.45	12.74	15.84
	Hay produced (tons)	0.27	0.50	0.35	0.75	0.28	0.60
Average							
	Labor (man hours)						
	Dec.-Jan.-Feb.	0.10	0.10	0.08	0.08	0.07	0.07
	March-April	1.04	1.07	0.78	0.80	0.88	0.90
	May-June	1.18	1.21	0.89	0.91	1.38	1.42
	July-August	0.17	0.17	0.12	0.12	0.17	0.17
	Sept.-Oct.-Nov.	0.78	0.78	0.56	0.56	0.95	0.95
	Operating capital[c] ($)	6.77	13.83	5.11	10.86	5.83	13.32
	Net return ($)	8.33	8.82	7.52	6.20	10.50	8.70
	Feed grain produced (bu.)	12.37	18.54	10.35	13.96	13.48	18.16
	Hay produced (tons)	0.30	0.55	0.53	0.85	0.32	0.68
Superior							
ABOVE AVERAGE	Labor (man hours)						
	Dec.-Jan.-Feb.	0.11	0.11	0.09	0.09	0.08	0.08
	March-April	1.17	1.17	0.88	0.88	0.96	0.96
	May-June	1.27	1.27	0.96	0.96	1.44	1.44
	July-August	0.18	0.18	0.13	0.13	0.18	0.18
	Sept.-Oct.-Nov.	0.77	0.77	0.57	0.57	0.95	0.95
	Operating capital[c] ($)	10.92	14.40	8.45	11.29	10.34	14.04
	Net return ($)	10.40	10.57	7.65	7.60	11.47	10.78
	Feed grain produced (bu.)	17.46	20.47	13.69	15.69	19.72	20.47
	Hay produced (tons)	0.43	0.60	0.80	0.95	0.64	0.76

[a]Soil classes are described in the section on land restrictions in the text.

[b]Subscript number (0) on rotation symbol means no fertilization; it applies to low level and average management. Subscript (1) refers to intermediate fertilization rate used by superior managers. Subscript (2) refers to high rate of fertilization used at all three levels of management.

[c]Operating capital includes production cost, spraying, shelling, seed, and fertilizer.

meadow (COM), corn-oats, meadow-meadow (COMM), and corn-corn-oats-meadow-meadow (CCOMM).

For each rotation, two levels of commercial fertilization are considered. Superior managers can use either intermediate or high rate of application. Average and low level managers use high rate or no fertilizer. A crop activity (production possibility) is defined as a combination of rotation and fertilization level. Hence, there are six to eight crop activities for each soil class at each level of management. Resource requirements for the various cropping systems are shown in Tables 4, 5, 6, and 7. Crop yields and fertilization rates are included in Tables 23 and 24.

Livestock enterprises

Resource requirements for livestock units are specified in Table 8. Each enterprise is represented at three management levels by variations in feeding efficiency, selling dates and prices, practices used, and in amount invested in equipment and facilities. Detailed descriptions of variations in practices used are in Appendix A, and their effects are reflected in the basic input-output data presented in Tables 25 through 33. The six litter hog system for average managers, and both the four and six litter systems for low level managers have not been considered. They are regarded as unfeasible with the management practices assumed. Capital inputs for cattle feeding include the cost of 32 and 20 square

Table 8. Resource requirements and returns of selected livestock activities at three management levels

Activity and management level	Labor					Feed			Building space units[b]	Capital $	Net return $
	Dec.-Jan.-Feb.	March-April	May-June	July-August	Sept.-Oct.-Nov.	Corn equiv. bu.	Hay[a] tons	Pasture days			
Beef cows, sell calf											
Low	4.390	2.965	3.456	3.108	3.981	0.00	1.20	267.0	0.0	204.22	49.61
Average	4.390	2.965	3.456	3.108	3.981	0.00	1.20	267.0	0.0	214.63	57.95
Superior	4.390	2.965	3.456	3.108	3.981	0.00	1.20	267.0		225.72	66.68
Beef cows, feed out calf											
Low	7.590	4.515	8.758	8.333	7.557	39.76	1.876	293.6	0.6	319.42	98.77
Average	7.590	4.515	8.758	8.333	7.557	45.44	1.972	297.4	0.6	339.32	129.55
Superior	7.590	4.515	8.758	8.333	7.557	51.10	2.068	301.2	0.6	356.41	162.85
Steer calves, drylot fed											
Low	3.010	2.380	5.395	5.333	2.293	66.30	0.706	0.0	0.6	119.56	95.43
Average	3.010	2.380	5.395	5.333	2.293	66.30	0.706	0.0	0.6	126.96	112.49
Superior	3.010	2.380	5.395	5.333	2.293	66.30	0.706	0.0	0.6	126.96	130.33
Steer calves, pasture fed											
Low	3.200	1.550	5.352	5.267	2.407	56.80	0.964	38.0	0.4	118.58	94.42
Average	3.200	1.550	5.352	5.267	2.407	56.80	0.964	38.0	0.4	123.75	111.96
Superior	3.200	1.550	5.352	5.267	2.407	56.80	0.964	38.0	0.4	126.71	130.41
Yearlings, long fed											
Low	6.300	4.200	4.869	1.718	3.818	54.20	1.26	0.0	0.0	157.67	72.51
Average	6.300	4.200	4.869	1.718	3.818	54.20	1.26	0.0	0.0	162.07	89.00
Superior	6.300	4.200	4.869	1.718	3.818	54.20	1.26	0.0	0.0	165.07	106.04
Yearlings, short fed											
Superior	6.300	4.200	5.230	5.059	7.159	80.20	1.94	0.0	0.0	188.65	247.42

[a]Hay fed to hogs is purchased. Expense is included in variable costs.

[b]One unit = 50 square feet, or enough space for one sow and two litters per year or for one beef cow and calf.

Table 8. (Continued)

Activity and management level	Labor					Feed			Building space units[b]	Capital $	Net return $
	Dec.-Jan.-Feb.	March-April	May-June	July-August	Sept. Oct.-Nov.	Corn equiv. bu.	Hay[a] tons	Pasture days			
Hogs, one litter											
Low	4.352	3.016	3.722	3.322	4.677	91.097	0.000	25.498	0.75	98.02	167.18
Average	4.352	3.016	3.722	3.322	4.677	93.282	0.018	29.38	0.75	117.78	208.22
Superior	4.352	3.016	3.722	3.322	4.677	98.211	0.025	37.44	0.75	137.01	262.63
Hogs, one litter, bldg. purchase											
Low	4.352	3.016	3.722	3.322	4.677	91.097	0.000	25.498	0.00	161.77	167.18
Average	4.352	3.016	3.722	3.322	4.677	93.282	0.018	29.38	0.00	181.53	208.22
Superior	4.352	3.016	3.722	3.322	4.677	98.211	0.025	37.44	0.00	200.76	262.63
Hogs, two litter											
Low	8.498	7.245	7.793	5.639	9.986	206.916	0.000	28.38	1.00	169.16	332.31
Average	8.811	8.654	6.266	5.717	9.712	202.824	0.031	31.30	1.00	222.11	418.14
Superior	10.260	7.793	5.639	6.696	8.772	213.888	0.054	36.48	1.00	290.00	520.52
Hogs, two litter, bldg. purchase											
Low	8.498	7.245	7.793	5.639	9.986	206.916	0.000	28.38	0.00	254.16	332.31
Average	8.811	8.654	6.266	5.717	9.712	202.824	0.031	31.30	0.00	307.11	418.14
Superior	10.260	7.793	5.639	6.696	8.772	213.888	0.054	36.48	0.00	375.00	520.52
Hogs, four litter, partial bldg. purchase											
Average	22.030	13.264	12.256	12.644	17.376	408.400	0.101	0.00	1.88	296.59	837.64
Superior	22.185	11.868	12.644	12.334	18.539	423.700	0.103	0.00	2.40	318.06	966.54
Hogs, four litter, complete bldg. purchase											
Average	22.030	13.264	12.256	12.644	17.376	408.400	0.101	0.00	0.00	414.09	837.64
Superior	22.185	11.868	12.644	12.344	18.539	423.700	0.103	0.00	0.00	468.06	966.54
Hogs, six litter, partial bldg. purchase											
Superior	29.056	20.888	20.420	18.904	27.422	637.200	0.154	0.00	2.40	367.15	1400.02
Hogs, six litter, complete bldg. purchase											
Superior	29.056	20.888	20.420	18.904	27.422	637.200	0.154	0.00	0.00	517.15	1400.02

feet, respectively, of concrete per head fattened by superior and average managers. A brief summary of the general nature of each livestock enterprise follows.

Pasture fed calves Good to choice 400 pound calves are purchased in October and wintered on roughage and limited grain. They are put on pasture in early May and are gradually brought to a full feed of grain. By August 1, they are transferred to drylot, and full fed until marketed at choice grade in October. Death loss is 3% of purchase weight.

Drylot fed calves Good to choice 400 pound calves are purchased in October and wintered on roughage plus limited grain. They are brought to full grain feed in March, carried to choice grade in drylot, and marketed in late September. Death loss is 3% of purchase weight.

Long fed yearlings Good to choice 650 pound yearlings are purchased in October and wintered on roughage. They are brought to full grain feed by February 1, and fattened in drylot to be marketed in July. Death loss is 1.5%.

Short fed yearlings--superior managers only Good to choice 700 pound yearlings are purchased in October, started on roughage, and brought to full drylot grain feed by January 1. They are fed to choice and marketed in March. The capital is reinvested in equal numbers of good to choice 700 pound yearlings purchased in April, which are brought to

full feed by July 1, and marketed in September. Death loss is 0.75%.

Beef cow, sell calf Stock cows are bred to calve in the spring. Cow and calf are carried on pasture, and the calf is marketed in October. Cows calve at 2 years of age and 16% replacement stock is kept.

Beef cows, feed out calf Stock cows are bred to calve in the spring. Cow and calf are carried on pasture. Cows calve at 2 years of age, and 16% replacement stock is kept. The calves are wintered on roughage, and are brought to full feed of grain on pasture starting in May of the following summer. By August 1, they are transferred to drylot, and full fed until marketed at choice grade in October.

One litter hogs Gilts are bred to farrow in late May, and are moved to pasture two weeks later. Pigs are weaned at 6 to 8 weeks, and sows are sold after they dry up. Pigs are fed on pasture, allowed to clean up cornstalks, and are finished in drylot to be sold in December. Death loss after weaning is 1.5%. Size of the enterprise is limited to buildings available on the farm, and no concrete is poured.

One litter hogs with building purchase This system is identical to the one just described, except that the capital requirement includes cost of new portable buildings to house the enterprise (10). Use of this alternative allows expansion

of the conventional one litter system after available building space is filled.

Two litter hogs Sows farrow twice yearly, in spring and fall. Spring pigs are moved to pasture to be fed out. Fall pigs are handled on cornstalks and in drylot. Pigs are weaned at 6 to 8 weeks of age. Replacement gilts are kept as needed. Capital requirements for superior and average managers include the cost of 15 and 10 square feet, respectively, of concrete floor per fall pig weaned. Size of the enterprise is limited to building space available on the farm.

Two litter hogs with building purchase This is the above described system with cost of new portable building space included in the capital inputs, which allows expansion of the conventional two litter system after available building space is filled.

Four litter hogs This alternative is open to average and superior managers only. Two groups of sows farrowing twice yearly are kept. Each group farrows in winter and summer, with one month between groups during each farrowing season as a disease barrier. This procedure is preferred to farrowing every other month, since it avoids a heavy hog labor requirement during the busy spring and fall crop seasons. The litters and sows are moved from the farrowing house to the nursing-growing-finishing sheds when the pigs are 2 weeks old. At 4 to 5 weeks, the pigs are weaned by moving the sows to the

Table 9. Use of hog facilities by function for the four litter system

Management level	Sow group	Farrowing house	Nursing-growing-finishing 1	Nursing-growing-finishing 2	Sow colony 1	Sow colony 2
Average	1	Dec. 1 to Jan. 15	Jan. 1 to June 1		Feb. 15 to June 1	
	2	Feb. 1 to March 15		March 1 to August 1		April 15 to August 1
	1a	June 1 to July 15	July 1 to Dec. 1		Aug. 15 to Dec. 1	
	2a	Aug. 1 to Sept. 15		Sept. 1 to Feb. 1		Oct. 15 to Feb. 1
Square feet per unit of activity		36	47	47	15	15
Superior	1	Jan. 1 to Feb. 15	Jan. 21 to June 21		March 15 to July 1	
	2	March 1 to April 15		March 21 to August 21		May 15 to Sept. 1
	1a	July 1 to Aug. 15	July 21 to Dec. 21		Sept. 15 to Jan. 1	
	2a	Sept. 1 to Oct. 15		Sept. 21 to Feb. 21		Nov. 15 to March 1
Square feet per unit of activity		36	60	60	15	15

Table 10. Use of hog facilities by function for the six litter system with superior management

Sow group	Farrowing house	Nursing house	Growing-finishing 1	Growing-finishing 2	Sow colony 1	Sow colony 2
1	Jan. 1 to Feb. 15	Feb. 1 to March 15	March 15 to June 15		March 15 to July 1	
2	March 1 to April 15	April 1 to May 15		May 15 to Aug. 15		May 15 to Sept. 1
3	May 1 to June 15	June 1 to July 15	July 15 to Oct. 15		July 15 to Nov. 1	
1a	July 1 to Aug. 15	Aug. 1 to Sept. 15		Sept. 15 to Dec. 15		Sept. 15 to Jan. 1
2a	Sept. 1 to Oct. 15	Oct. 1 to Nov. 15	Nov. 15 to Feb. 15		Nov. 15 to March 1	
3a	Nov. 1 to Dec. 15	Dec. 1 to Jan. 15		Jan. 15 to April 15		Jan. 15 to May 1

sow colony. The pigs remain in the sheds and are kept in confinement on concrete until sold. Available buildings are adapted for use as the nursing-growing-finishing sheds; new permanent farrowing facilities and sow shelters are built; and concrete feeding floors are poured. Expansion is limited to the use of the present facility for the pigs. The use of facilities and space requirement estimated for each unit are shown in Table 9.

Four litter hogs with building purchase This system is considered by average and superior managers only. It is a duplicate of the four litter system described above, except that capital inputs include the cost of nursing-growing-finishing facilities. This allows increased specialization in the four litter system after the available buildings are filled.

Six litter hogs This system is considered by superior managers only. Three groups of sows farrow on the two litter system. A group farrows every second month, so that pigs are produced in six months of the year. Litters are moved from the farrowing house to nursing sheds at 2 weeks of age. They are weaned at 4 to 5 weeks. The pigs are shifted to the growing-fattening sheds and kept in confinement on concrete until sold. Sows are transferred to the sow colony. Available buildings are used for growing-fattening quarters. New permanent farrowing facilities, sow shelters,

nursing sheds, and feeding floors are built. The expansion is limited to capacity of the growing-fattening unit. The use of facilities and space requirements of each unit are presented in Table 10.

Six litter hogs with building purchase This system is available to superior managers only. It is the same as described above, but includes the cost of growing-fattening facilities in the capital coefficient so that expansion beyond limits of available building capacity is possible.

Transfer activities

Certain other activities are necessary for these farm situations to be planned by linear programming. They are described below.

May-June labor purchase Initial returns to labor are usually greater for crop than for livestock production. The crop labor requirements are especially heavy during May and June. Hence, a shortage of May-June labor often severely limits livestock production. A labor purchase activity of this period is included to allow a larger livestock program. As a result, labor during other periods can be more fully utilized and a larger income realized. Labor will be hired during this period as long as it returns more than the $1.10 per hour wage rate charged.

Corn buying and corn selling Feed grains will normally be sold as final products on some farms. On other farms, they are raised to be used as inputs for livestock production. Hence, the net return to crop rotations has been calculated as value of soybeans less variable costs. This implies no direct return to feed grain and forage in the rotation. A corn (feed grain) selling activity at a market price of $1.20 per bushel has been included to give the grain a value. However, this grain may be worth more than market price as livestock feed. Consequently, no charge for home raised feed has been made in computing livestock returns. The linear programming procedure imputes the value of grain in livestock feeding. Grain is sold only if feeding value is less than $1.20 per bushel. It is also possible that grain in excess of production could be fed profitably. A grain buying activity is included at a farm delivered price of $1.30 per bushel. After grain production is fed, more will be purchased only if the imputed value in feeding exceeds $1.30 per bushel.

Hay transfer Rotation forage can be used for pasture or hay. It is initially handled as hay to distinguish it from permanent pasture, which cannot produce hay. Hay and pasture cannot be bought or sold. Their only values in the rotation are for complementarity with grain production, for reducing crop labor requirements during spring labor squeezes,

and for livestock feed. After permanent pasture has been fully used by livestock, it may be profitable to pasture some of the rotation forage. Hence, an activity is included to transfer unused hay to pasture equivalents. One ton of hay equals 50, 62.5, and 75 Animal Unit Days, respectively, for low level, average, and superior management farms. No cost is involved since hay harvest costs and pasture fencing inputs are charged to the livestock which use the forage.

Building transfer Hog building space is specialized, but cattle buildings can be used for cattle or hogs. Since the cattle space may be more valuable in hog production, an activity is included to allow such use. Costs included in hog production activities for repair of specialized buildings are assumed to cover conversion expense.

Units of Output

The unit level in which the output of all previously described enterprises is stated has been arbitrarily chosen. For this study, the crop unit is one acre. If, for example, a four year rotation such as corn-corn-oats-meadow is the crop activity, the inputs, output, and net prices are for ½ acre corn, ¼ acre oats, and ¼ acre meadow.

A beef cow unit is one cow and calf, with bull service treated as a cash expense. Feeder calf and long fed yearling activities are defined for one steer. Short fed yearlings

include two steers, one fattened during each of the two feeding periods during the year.

For hog activities, a one litter system includes one sow and one spring litter; a two litter system is one sow and two litters per year; a four litter system is two sows farrowing in different months and having two litters each during the year; a six litter system is three sows farrowing on a schedule of every other month, each sow producing two litters each year.

Prices Used

Prices used in this study are summarized in Table 11. An attempt is made to maintain the average historical relationships among farm prices, while adjusting the absolute level to $1.20 corn price per bushel. As long as these relationships continue, the farm plan which maximizes profit will be the same, regardless of the absolute price level. Of course, the amount of profit will vary with the price level.

The adjusting method used was to divide the average price of each product over a "price cycle" by the average price of corn over the same period and multiply the resulting ratio by the $1.20 corn price. The price cycle periods used were 1937-57 for cattle, 1951-57 for hogs, and 1953-57 for grains. The calculation is illustrated for the selling price of choice fat cattle in September:

Table 11. Prices used[a]

Item	Buying date	Selling date	Buying price: Gilts, barrows $	Buying price: Sows $	Buying price: Other $	Selling price $
Seed[b] (Iowa prices)						
Alfalfa (lb.)	March 15				0.50	
Smooth bromegrass (lb.)	March 15				0.51	
Oats (bu.)	March 15				1.60	
Corn (bu.)	March 15				11.50	
Soybeans (bu.)	April 15				3.10	
Feed (Iowa prices)						
Cattle supplement (cwt.)	July 1				4.75	
Hog supplement (cwt.)[c]	July 1				6.50	
Fertilizer (U. S. prices)						
Nitrogen (lb.)	April 15				0.13	
Phosphorus (lb.)	April 15				0.09	
Potassium (lb.)	April 15				0.05	
Crops (Iowa prices)						
Corn equivalent (bu.)		Yr. ave.				1.20
Soybeans (bu.)		Yr. ave.				2.29
Hogs (int. Iowa prices per cwt.)[d]		Jan.	15.74	13.66		
		Feb.	16.16	14.05		
		March	16.17	14.20		
		April	16.87	14.93		
		May	17.58	15.17		
		June	17.93	14.91		
		July	17.84	14.62		
		August	17.84	15.01		
		Sept.	16.70	14.58		
		Oct.	15.22	13.60		
		Nov.	14.25	12.81		
		Dec.	14.86	12.98		
Cattle (Omaha prices)[e]						
Drylot calves	Oct.	Sept.			20.52	22.28
Pasture calves	Oct.	Oct.			20.52	22.13
Long fed yearlings	Oct.	July			18.89	21.73
Short fed yearlings	Oct.	March			18.89	20.52
Short fed yearlings	April	Sept.			19.31	22.28
Beef cow	--	Yr. ave.			--	14.85
Beef calf	--	Oct.			--	20.52

[a]Data from (13, 16, 17, 18).

[b]Twenty-five per cent of oats and soybean seed was purchased at these prices.

[c]Composite price of 10% sow supplement, 3% pre starter, 12% starter, 30% grower, and 45% hog supplement.

[d]Prices for average management. Add $.40 per cwt for superior; subtract $.40 per cwt. for low level.

[e]Prices for average management. Add $.99 per cwt for superior; subtract $.99 per cwt for low level.

$$\text{average adjusted price of fat cattle in Sept.} = \frac{\text{average Sept. price of fat cattle for 1937-57}}{\text{average corn price for 1937-57}} \times \$1.20$$

Current prices unadjusted for items purchased, and yearly average grain prices were used. Monthly prices for cattle and hogs were utilized to reflect seasonal differences in the various livestock activities accurately.

Cattle and hog prices were also varied by level of management to reflect differences in quality of animal marketed and in choice of selling day. The average adjusted prices as computed above were used for average management. The adjusted difference (using the same adjusting procedure) between this average price and the price quoted for the next lower grade was used as a price range. This range was centered on the average adjusted price, assuming that the prices for low level and superior management were equidistant below and above the average management price. For example, the average adjusted price for choice 900 to 1100 pound slaughter cattle in September was $22.28 per hundred pounds. The adjusted difference between choice and good grades was $2.96 per hundredweight. Hence, the price range assumed was $20.80 to $23.76. Thinking of three sub-ranges, one for each level of management, the sub-range for each level is $0.99 per hundredweight. Hence, the sub-ranges are $20.80 to $21.79, $21.79 to $22.78, and $22.78 to $23.76. The centers of these sub-ranges, or $21.29 for low level, $22.28 for average, and $23.27 for

superior management, were used in this study for the prices of September marketed fat cattle. Since limited investigation showed only small differences in range for other months and grades of cattle, this same range was assumed for all cattle prices. A similar procedure was used in computing hog price differentials of $0.40 per hundredweight.

Net prices were used in this study. That is, market value minus variable cost is the "net return" shown for the activities. To determine net profit, fixed costs for a 160 acre, owner operated farm, which are estimated in Table 12, must be deducted. This has been done in the analysis of results in this thesis.

Table 12. Estimated minimum fixed costs for a 160 acre farm operated by the owner

Item	New value	Years to depreciate	Annual cost C-W	Annual cost S-G-H
Tractor, 30-40 belt H. P.	$3090.00	10	$309.00	$309.00
Plow, two 14 in.	279.00	15	18.60	18.60
Tandem disc, 8 ft.	322.00	15	21.47	21.47
Corn planter, 2 row	276.00	15	18.40	18.40
Harrow, 4 section	142.00	15	9.47	9.47
Cultivator	294.00	15	19.60	19.60
Wagons (2)	400.00	12	33.33	33.33
Manure spreader	493.00	15	32.87	32.87
Sprayer	195.00	15	13.00	13.00
Pickup truck, 1/2 ton	1840.00	10	184.00	184.00
Corn picker, 1 row	1240.00	15	82.67	82.67
Power mower	366.00	14	26.14	26.14
Endgate seeder	80.00	15	5.33	5.33
	$9017.00		$773.88	$773.88
Personal property taxes and insurance (1.5% of $9017.00)			135.26	135.26
Real estate taxes				
Clarion-Webster $3.25 x 160 acres			420.00	
Shelby-Grundy-Haig $1.62 x 160 acres				259.20
Miscellaneous				
Electricity			30.00	30.00
Telephone			25.00	25.00
Newspapers and magazines			25.00	25.00
Farm organization dues			20.00	20.00
Total fixed costs			$1429.00	$1268.00

CHAPTER IV: METHOD OF ANALYSIS

A farmer with one of the described resource situations and the enterprise alternatives outlined has to choose among many possible organizational plans. In the absence of strong overriding preferences, the choice criterion is maximum returns from his given resources.

Linear programming, the planning technique used in this study, is a mathematical method of choosing the most profitable plan. Given the feasible enterprises and pertinent resource restrictions, the method insures that the resource allocation specified produces maximum profit.

A modification of the ordinary simplex method of linear programming allows continuous variation of the capital restriction from zero to an unlimiting level. The result is a set of maximum profit plans. They show the changing pattern of optimum resource use as capital supply of otherwise homogeneous farm increases.

Only this brief statement of the applicability of linear programming to the problem outlined is given. Heady and Candler (7) have presented detailed explanations of the logic, assumptions, and procedures of the method.

Procedure Used

Six basic 160 acre farm situations were studied. They include farms in two soil areas operated at three different management levels. For each farm situation, a variable capital set of maximum profit plans was computed. These plans are benchmarks, which show the highest incomes possible under each resource situation. Existing farm organizations can be compared with these plans to determine how income might be increased in an individual situation by adding capital, management, or a combination of the two resources.

The following direct comparisons were made among the benchmark plans: (1) Variable capital plans for the same management level were contrasted to determine effects of additional capital. (2) Plans for the three management levels were contrasted at similar resource use levels to show effects of better overall farm management. (3) Effects of purchasing grain, May-June labor, and building space were determined in the various situations. All of these comparisons are among optimum farm plans. Income changes would be more pronounced if the comparison were with actual farm situations, where organization is not usually optimum.

Comparisons described in the previous paragraph answer questions such as: "What are the effects of making more capital available to the farm as a whole?" and "What will be the result of giving aid to improve overall management of the

farm?" However, contributions of hog integrating firms have been more specialized forms of capital and management aid. Such contributions are available only to four or six litter enterprises. A separate analysis was conducted to study the effects of this type of capital or management aid in each soil area.

Specialized management contributions of integration were studied using the basic low level management situations. Superior management four and six litter hog enterprises replaced building purchase for one and two litter systems as production alternatives. This choice of situation allows the specialized management aid to make the maximum contribution to farm income. That is, hog production under the multiple systems is raised from low level to superior management results. Further, no charge is assumed for the management aid. In many farm situations (i.e. situations where the operator is better than a low level manager on his other enterprises, or where the integrating firm provides less aid than necessary to obtain superior management results) the contribution of integration would be less.

Effects of capital contributions by integrating firms were studied in the superior management situations. Plans were computed for a single typical operating capital level in each soil area. Additional outside capital was assumed to be available for breeding stock and cash expenses of the multiple hog systems. This loaned capital was repaid with 6%

interest from sales receipts at the end of the year. The purchase of any necessary additional buildings and equipment was made with operating capital. The situation chosen is most favorable to the integrated plans in two ways. First, the integrator provides a large portion of capital required, which minimizes initial investment by the operator. Second, the superior manager has the highest return on capital, and hence can most nearly be expected to realize a profit above the 6% interest charge. Less productive operators or smaller capital contributions by integrators would reduce any gains realized.

The following specific steps were taken in the analysis:

1. Profit maximizing variable capital plans were computed and presented for 160 acre farms in each soil area at each management level.
2. Plans with similar capital levels were compared at the three management levels.
3. Effects of grain, hog building, and May-June labor purchase on income and use of other resources were analyzed.
4. Plans for low level management were recomputed and analyzed, assuming superior management four and six litter hog systems as production alternatives.
5. Plans for superior management were recomputed and analyzed, at a discrete capital level, with a capital lending provision for the four and six litter systems.

Method of Presentation

The following three chapters present discussion of profit maximizing plans for each of the situation groups studied. Chapter V presents plans for the Clarion-Webster soil area. Chapter VI analyzes plans of Shelby-Grundy-Haig situations. Chapter VII is devoted to analysis of plans with capital and management aid provided for the multiple hog systems.

Within each chapter, discussion is presented separately for low level, average, and superior management. The set of variable capital solutions for each management level is presented numerically in a table, graphically in the accompanying figure, and verbally in the discussion. Capital input required for cultivating all cropland is the minimum level considered. At the maximum, plans which return less than 5% on marginal capital invested are not presented. Wherever the word capital is used in the following chapters, it is understood to mean operating capital.

Profit figures in the tables represent net revenue, since all variable costs plus fixed costs of $1429 for Clarion-Webster and $1268 for Shelby-Grundy-Haig farms have been deducted from gross returns. Grain sale is indicated by a plus (+) and grain purchase by a minus (-) in the "corn surplus or deficit" column. Resources which limit plans (i.e. supply of a resource is completely used by the plan) are indicated in the "additional resources limiting" column of each table.

Hence, resources restricting for any plan are those shown as restricting for the plan and for all previous plans. Livestock units have been rounded to whole numbers, and therefore resource use will not check exactly with supplies. For the Shelby-Grundy-Haig plans, Roman numerals after the rotation symbol denote the land class to which the rotation applies.

In the figures, income above fixed cost is shown on the vertical axis, and operating capital input on the horizontal axis. The area under the income line is divided into sections to indicate contributions of each enterprise at each capital level. Grain is credited to the rotation and charged to livestock consuming it at market prices. The appropriate table shows the number of units of each enterprise needed to give the income pattern shown.

Discussion in the text is centered on explaining changes in enterprise combinations as the resource pattern changes. Implications of the results are indicated at various points.

All situations in this study are computed for average price relationships. Other plans might be optimum for specific years when price relationships varied from the average. However, as long as these price patterns continue over time, the plans presented are long run optima.

CHAPTER V: OPTIMUM PLANS FOR CLARION-WEBSTER FARM SITUATIONS

Maximum profit plans for 160 acre, owner operated farms in the Clarion-Webster soil area are presented in this chapter. Three separate analyses are done. First plans for several capital levels at each management level are presented to emphasize effects of added capital. Second, plans at the three levels of resource efficiency are analyzed to determine effects of improved management. Finally, plans with and without resource hiring are compared to show effects of "fixity" of production plant on the level of income expected from different capital inputs.

Profit Maximizing Plans

The plans presented in Tables 13, 14, and 15 are optimum for farms with the resource situations described. The amounts of capital used in certain of the plans are consistent with one of the following levels of intensification: (1) no hired labor used, (2) crop-intensive CCSb rotation used on all cropland, (3) livestock production limited to capacity of present buildings, or (4) feed grain consumption balanced with production. Operators tend to group themselves around one of these levels of intensification because of personal preferences and present net worth. Individual operators may tend to lend out

or borrow capital until their supply matches the amount needed for one of the plans presented.

Low level management

Table 13 and Figure 1 present the plans at five capital levels for farms with low level management practices used on all enterprises.

When capital is very limited, only enterprises which use capital most efficiently are included in the optimum plans. This is because other resources are not being fully used. Therefore, the enterprise which gives the highest return per dollar invested is chosen. Accordingly, at the $1,177 capital level, the entire 150.3 acres is planted to the CCSb rotation without fertilizer. As capital is added, additional resources become limiting and affect enterprises which are included in the plan. For example, all available land is cropped in Plan 1 (Table 13). Hence, plans at higher capital levels will consider return to both land and capital in selecting enterprises. Therefore, to maximize profit, farmers with limited capital must choose quite different plans than do farmers who have similar resources, but larger capital supplies.

Plan 2 indicates that the first capital above requirements for cultivation will be invested in fertilizer for the CCSb rotation. Fertilizer returns more to the limited land and capital than would the other production alternatives because it produces a large yield response even at the low

management level.

When capital is increased to $3,679 and beyond, the one litter hog system is included in the optimum plans. It is chosen over the alternative two litter system or the cattle enterprises because of high return per hour of May-June labor and a low capital requirement. The high return is a result of low pre-farrowing May-June labor requirements per unit. Capital input is low because the May-June farrowing and pasture raising plan requires few buildings. At higher capital levels, inclusions of labor purchase in the plans indicates that its imputed marginal return in hog production is greater than the $1.10 per hour cost of hiring.

At the $4,444 capital level, the hog enterprise has used all non-cropland pasture produced. Hence, more forage is needed to expand livestock output. Consequently, enough $CCOM_2$ is substituted for $CCSb_2$ at higher capital levels to provide the minimum forage needed for the livestock program. The substitution of a rotation which has a lower cash return demonstrates that maximum farm returns is not synonymous with maximum returns from the rotation.

The hog enterprise in Plans 6 and 7 requires purchase of buildings at a cost of $63.75 per unit. Between Plans 5 and 6, $3,637 of additional capital returns $728. The marginal return of approximately 20% on capital invested in buildings, additional labor, and hog production costs indicates that

for type C farms with

Table 13. Optimum Clarion-Webster farm plans with low level management and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	1,177	4,798	$CCSb_0$	150.3		Land	+ 4,258	0
2	3,679	6,801	$CCSb_2$	150.3		May-June labor	+ 5,169	0
			Hogs, one litter		12			
3	3,973	6,975	$CCSb_2$	150.3		Pasture	+ 4,896	11
			Hogs, one litter		15			
4	4,444	7,176	$CCSb_2$	145.5		Hog bldg.	+ 4,420	22
			$CCOM_2$	4.8				
			Hogs, one litter		20			
5	6,695	8,094	$CCSb_2$	121.0		Cattle bldg.	+ 2,125	78
			$CCOM_2$	29.3				
			Hogs, one litter		44			
6	10,332	8,822	$CCSb_2$	98.4		Corn	0	130
			$CCOM_2$	51.9				
			Hogs, one litter		44			
			Hogs, one litter, bldg. purchase		22			
7	10,875	8,878	$CCSb_2$	96.4		March-April labor	- 170	135
			$CCOM_2$	53.9				
			Hogs, one litter		44			
			Hogs, one litter, bldg. purchase		24			

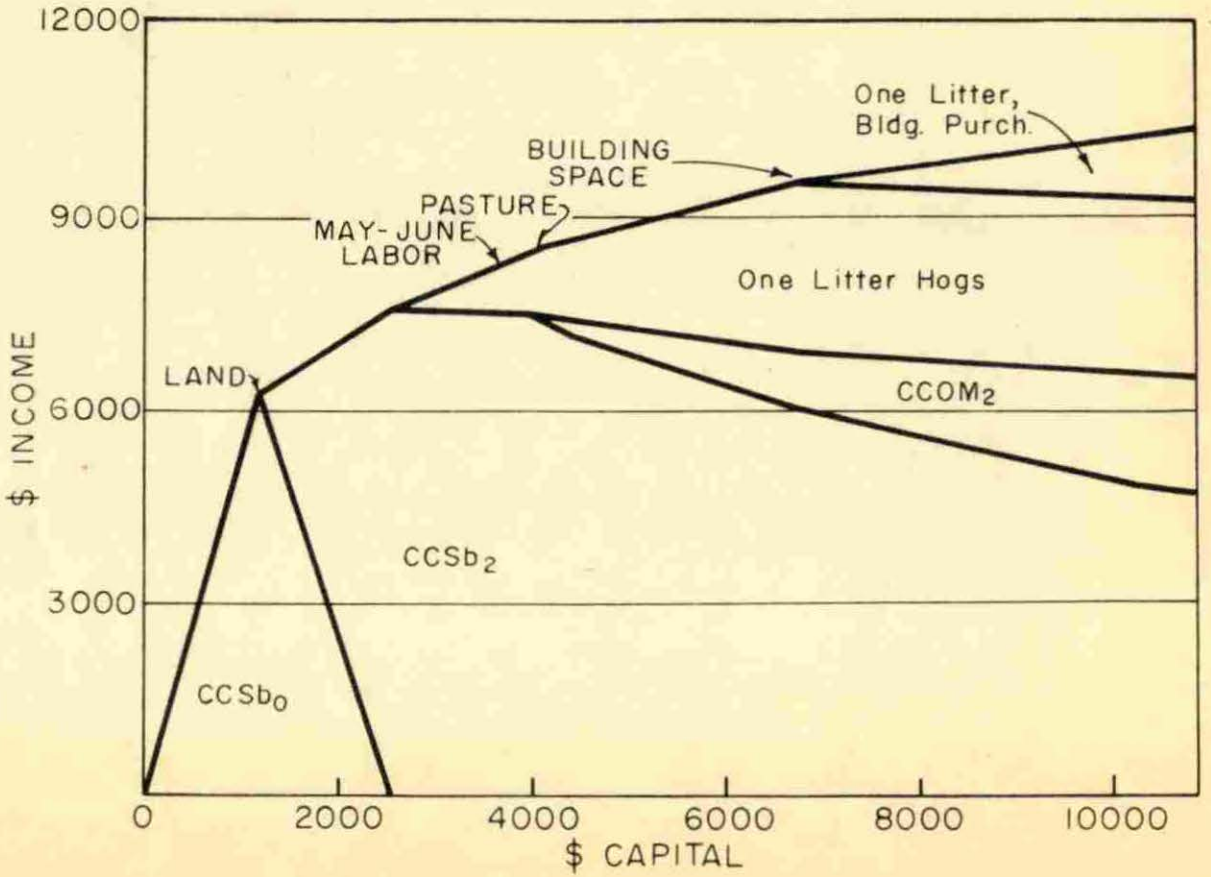


Figure 1. Optimum Clarion-Webster farm plans with low level management and different quantities of capital available.

building purchase is a profitable method of expanding livestock production if the capital can be acquired.

Average management

Maximum profit plans for Clarion-Webster, average management situations are shown in Table 14 and Figure 2.

The unfertilized CCSb rotation gives the highest return to very restricting capital. Yield response from fertilizer justifies its use in all situations where capital supply exceeds that required to cultivate the cropland.

With only May-June labor, land, and capital limiting, $CSbCOM_2$ produces the rotation forage required at and above the $5,955 capital level most economically. When, in addition, March-April labor becomes restricting, $CCOM_2$ is substituted for $CSbCOM_2$. Spring labor is released for hog production, and additional corn is produced. The value of hog and corn production added exceeds a loss of soybeans for cash sale. However, in practice the small acreages of a second rotation indicated in Plans 4 and 5 would not be produced. In Plan 5, for example, the 1.6 acres of meadow needed for forage would be added to permanent pasture and the $CCSb_2$ rotation increased to 148.7 acres.

A livestock program is used above the $4,051 capital level. The two litter hog system replaces the one litter system at the $5,955 capital supply. This change at first appears to be contradictory to profit maximization, since the

Table 14. Optimum Clarion-Webster farm plans with average management and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	1,285	5,139	$CCSb_1$	150.3		Land	+ 4,584	0
2	2,612	6,678	$CCSb_2$	150.3		---	+ 6,638	0
3	4,051	7,855	$CCSb_2$ Hogs, one litter	150.3	 12	May-June labor	+ 5,498	0
4	5,955	9,213	$CCSb_2$ $CSbCOM_2$ Hogs, two litter	148.0 2.3	 15	Hog bldg.	+ 3,568	5
5	7,338	10,167	$CCSb_2$ $CCOM_2$ Hogs, two litter	143.8 6.5	 21	March-April labor	+ 2,330	8
6	12,345	12,299	$CCSb_2$ $CCOM_2$ Hogs, one litter Hogs, one litter bldg. purchase	101.4 48.9	 44 25	Corn	0	15

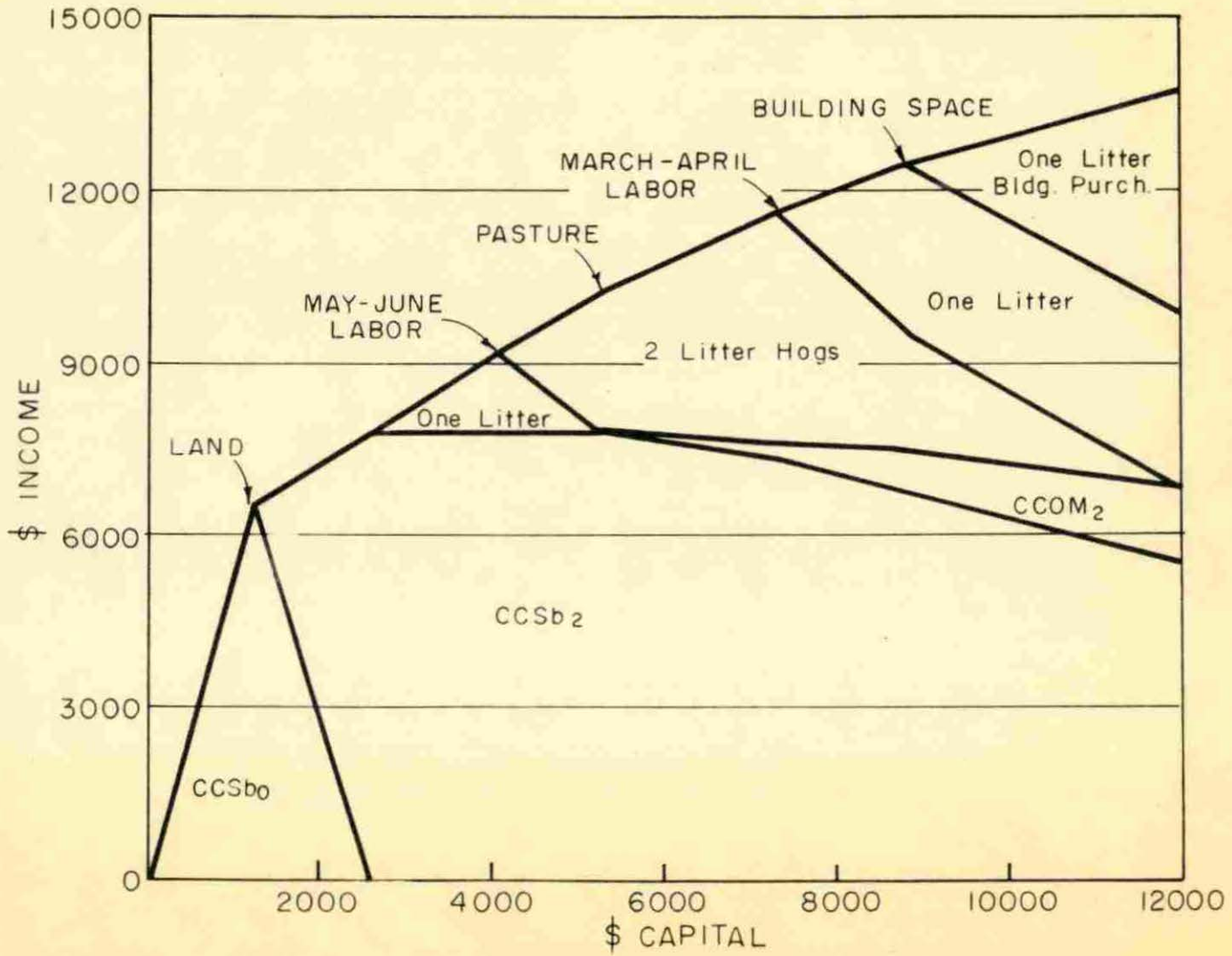


Figure 2. Optimum Clarion-Webster farm plans with average management and different quantities of capital available.

one litter system returns more per hour of the severely limiting May-June labor. However, hog building space, land, and pasture are also restricting. The two litter enterprise produces maximum total returns to these resources primarily because it uses buildings more fully. When capital increases to $12,345, the hog enterprise in the optimum plan reverts to the one litter system because March-April labor has become restricting. Limiting labor supply in all four spring months more nearly fits the requirements of the one litter system; although building space is not so fully used, hog output per hour of limiting labor is higher than with a two litter enterprise. Hence, there is a net addition to income. The four litter hog system and the cattle feeding enterprises were not optimum at any capital level because they use a larger proportion of their total labor requirements in the spring months than do the one and two litter hog systems. Also, the necessity of building purchase for the four litter system gives it a high capital requirement. Thus, return on capital is lower than with other enterprises.

Superior management

Optimum plans for Clarion-Webster farms operated with superior management on all enterprises are presented in Table 15 and Figure 3.

Fertilization of all cropland was one of the practices assumed in defining superior management of crops. Hence, the

crop production choice is between intermediate and high level fertilization. Also, minimum capital required for complete cultivation of cropland includes some cost of fertilizer. Therefore, minimum capital input considered is higher than for the other management situations. Accordingly, $2,170 is required to use the intermediate (1/2 of high rate) fertilized CCSb rotation, which maximizes return to very limited capital.

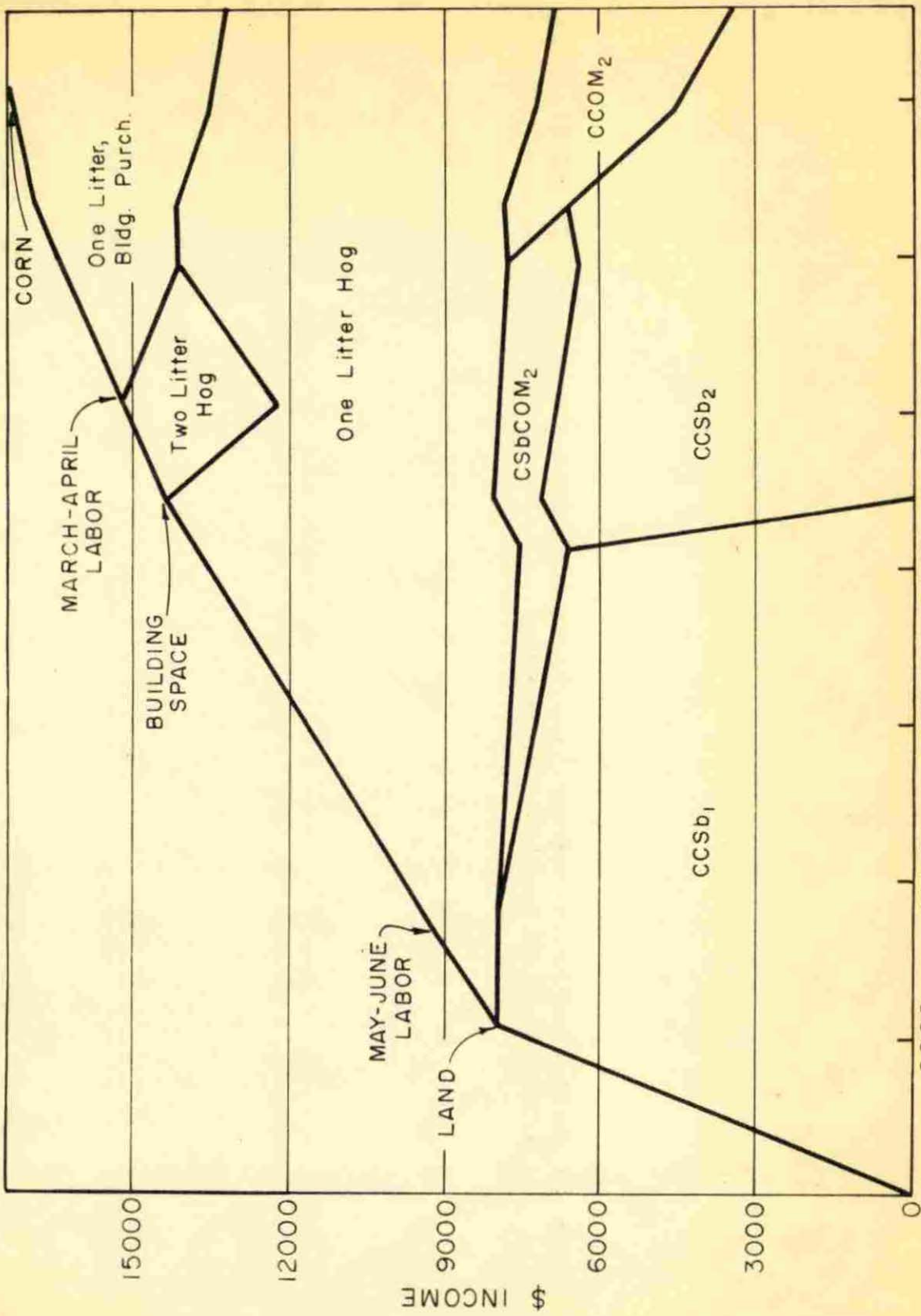
In the previously analyzed sets of plans, the next capital investment was for high level fertilization of the rotation. However, the superior manager produces 20 units of the one litter hog system and uses $8,895 of capital before investing in high level fertilization for the CCSb rotation. This indicates that return from the second increment of fertilizer is not as great as that from the hog enterprise. However, the low level and average management plans showed that high rate fertilization was more profitable than livestock production. Hence average return from the first and second increments is greater than from livestock, but return from the second increment alone is less than from livestock production. Therefore, return to capital from the first increment of fertilizer is relatively high.

Forage requirements for hogs are met at intermediate capital levels by substituting $CSbCOM_2$ for $CCSb_1$. Given the limiting resources, $CSbCOM_2$ is the lowest cost forage source. With $13,915 capital, March-April labor and corn limit.

Table 15. Optimum Clarion-Webster farm plans ~~with superior management~~ for type A farmer with and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	2,170	6,577	$CCSb_1$	150.3		Land	+ 6,128	0
2	3,403	7,920	$CCSb_1$	150.3		May-June labor	+ 5,217	0
			Hogs, one litter		9			
3	4,941	9,360	$CCSb_1$	143.3		Pasture	+ 4,124	31
			$CSbC\bar{O}M_2$	7.0		Hog bldg.		
			Hogs, one litter		20			
4	8,895	12,979	$CCSb_2$	125.6		Cattle bldg.	+ 2,407	100
			$CSbC\bar{O}M_2$	24.6				
			Hogs, one litter		44			
5	10,127	13,805	$CCSb_2$	128.6		March-April labor	+ 1511	111
			$CSbC\bar{O}M_2$	21.7				
			Hogs, one litter		29			
			Hogs, two litter		11			
6	13,915	15,850	$CCSb_2$	83.2		Corn	0	129
			$CC\bar{O}M_2$	67.1				
			Hogs, one litter		44			
			Hogs, one litter bldg. purchase		26			
7	20,064	16,713	$CC\bar{O}M_2$	150.3		---	- 1,867	72
			Hogs, one litter		44			
			Hogs, one litter bldg. purchase		43			

Figure 3. Optimum Clarion-Webster farm plans with superior management and different quantities of capital available.


CORN
One Litter, Bldg. Purch.
MARCH-APRIL LABOR
BUILDING SPACE
Two Litter Hog
One Litter Hog
MAY-JUNE LABOR
LAND
CSbCOM2
CCOM2
CCSb2
CCSb1
15000
12000
9000
6000
3000
0
$ INCOME
2000
4000
6000
8000
10000
12000
14000
$ CAPITAL

$CCOM_2$ replaces $CSbCOM_2$ as the forage source, since return from the added corn produced exceeds the value of soybeans sacrificed. The $CCOM_2$ rotation is used on the entire 150.3 acres with $20,064 of capital available. Forage production exceeds that needed for livestock. However, spring labor released permits expanded hog production. Grain production sacrificed is replaced by corn purchase for the hogs. This is profitable because of the return on the labor made available to hogs. The opportunity cost of expanded grain production (in hog production sacrificed) is greater than the grain purchase price of $1.30 per bushel.

Effects of Improved Overall Management

The livelihood of professional farm managers depends to a large extent on their success in improving a client's income. Agricultural extension personnel are also interested in raising farm income. Both groups contribute by encouraging the operators to use improved management practices and make needed adjustments in resource use. The limit of their potential contribution is the maximum amount which improved management can raise income. What is the potential gain resulting from assisting a low level manager? What are the marginal income contributions which management aid can make to the average manager? Does the profit maximizing combination of enterprises for a given situation depend on the

managerial ability of the operator?

Answers to these and similar questions are suggested by comparison of optimum plans at the three management levels presented in Tables 13, 14, and 15. Ideally, the comparison would be made with all factors except management level held constant. However, variable capital programming gives plans for situations in which some resource becomes restricting. Capital input in these situations is not constant for the three management levels. Hence, management can be compared for situations where capital input is only approximately constant.

Two typical resource use situations selected for special study are: (1) all May-June labor used, and (2) entire grain production fed to livestock. Plans for these resource use situations at the three management levels are reproduced in Table 15. Comparison at other resource use levels can be made by referring to Tables 13, 14, and 15.

Use all May-June labor

The outstanding feature of the Clarion-Webster farm plans limited to the family May-June labor supply is their similarity at all three management levels. Each produces the CCSb rotation, has a limited one litter hog system, and sells most of the grain raised. Custom and preferences may have resulted in a slightly different combination of enterprises on actual farms than indicated by these maximum profit plans. However,

this patterm indicates that the uniformity of organization of 160 acre Cornbelt family farms in an area is soundly based.

The income variation by management levels--i.e. the productivity of improved management practices--is relatively great for hogs, intermediate for cattle, and narrow for crop enterprises. Hence, since crop returns are the major income component in this situation, net return does not vary greatly by management level. The variation present is largely due to differences in returns from the small hog enterprise. Fewer units of hogs (but the same number marketed) are responsible for the superior manager requiring the lowest capital input, and yet having the highest income. This suggests that to some extent management has substituted for capital. Hence, young farmers who have the same resource situation but less capital than their neighbors could possibly realize the larger income by concentrating on superior management of livestock, where rewards are high.

Feed all grain produced

Acreages of grain produced and fed are 104.5, 110.8, and 105.8 for low level, average, and superior managers. Total feed grain production is 6,034 bushels for low level, 6,474 for average, and 6,861 for superior. These variations in totals from about the same grain acreage are a result of higher yields and, for the superior manager, less soybeans produced for sale.

Feed conversion rates vary with the management level. Hence, the superior manager sells 546 market hogs, the average manager sells 421 head, and the low level sells 317 head from the grain produced on about the same number of acres. Because of variation in litter size, each requires about the same number of sows. Hence, the management gains compound themselves. Better crop management allows higher grain production for hog feed. In addition, each bushel converts to a larger poundage of pork. Consequently, at capital levels which permit a large livestock program, management gains are multiplied. At these higher capital levels, a greater proportion of income is from livestock, for which the management spread in income is great. As a result of these factors, income spread is from $15,850 for superior managers to $8,822 for low level managers.

This compounding of benefit suggests that overall management aid offers high returns when capital is available for extensive livestock production. Hence, within a range, capital and management are complementary resources. Although management aid will allow better use of very limited capital (and to some extent, substitute for capital), its maximum contribution is realized when both factors are increased. This has two implications for an extension program. If the purpose of the program is to provide a minimum income level, then assistance in obtaining expansion capital will make the

Table 16. Comparison of certain optimum Clarion-Webster farm plans at different management levels

Characteristic and item	Unit	Management: Low level		Average		Superior	
Use all May-June labor							
Net return	$		6,801		7,855		7,920
Capital used	$		3,679		4,051		3,403
Grain sold	bu.		5,169		5,498		5,217
Enterprises	acres	$CCSb_2$	150.3	$CCSb_2$	150.3	$CCSb_1$	150.3
	units	Hogs, one litter	12	Hogs, one litter	12	Hogs, one litter	9
Feed all grain produced							
Net return	$		8,822		12,299		15,850
Capital used	$		10,332		12,345		13,915
Labor hired	hours		130		152		129
Enterprises	acres	$CCSb_2$	98.4	$CCSb_2$	101.4	$CCSb_2$	83.2
	acres	$CCOM_2$	51.9	$CCOM_2$	48.9	$CCOM_2$	67.1
	units	Hogs, one litter	66	Hogs, one litter	69	Hogs, one litter	70

efforts most productive. If the purpose is to make the largest dollars and cents contribution per unit of services given, then the worker will assist persons who have a larger capital supply.

Effects of Resource Hiring

Heavy crop labor requirements suggested that labor hiring would be profitable during the May-June period. Hiring would allow expansion of the livestock program, which would use other resources more fully. Another set of comparisons using Table 15 is appropriate to demonstrate that the hypothesis proved correct for all three management levels. Hiring about 2 weeks' labor in May-June essentially allowed conversion of a cash crop farm with a small supplementary hog program to a livestock farm. Income boosts were $2,021 for low level managers to $7,930 for superior managers.

Although building space is not nearly so limiting as May-June labor, building purchase is profitable at all the higher capital levels. Capital required increases rapidly with building purchase because the entire cost is charged. Hence, a relatively large investment is required to get the same total return as from a hog unit in present buildings. Still, return on investment is greater than 5%. Capital levels where building purchase is specified are higher than is available on many farms. Those clinging to "fixity" of resources

often fail to consider building purchase as a use of capital if it is available. This analysis indicates that borrowing money to buy buildings for hogs would be profitable under the assumed prices.

As expected, grain purchase is not needed at typical capital levels because of the large production. However, plans indicate that with some building purchase, it is profitable for Clarion-Webster farmers to feed all grain produced in cases where large capital supply is available.

CHAPTER VI: OPTIMUM PLANS FOR SHELBY-GRUNDY-HAIG FARM SITUATIONS

Plans which maximize profit for 160 acre farms in the Shelby-Grundy-Haig soil area are presented in Tables 17, 18, 19, and 20. Three land classes, which require different crop rotations, are found in each situation. There are 16.2 acres of Class I which is 0-1% slope, 68.6 acres of Class II which is 2-5% slope, and 26.6 acres of Class III which is 4-14% slope. The remaining 48.6 acres are permanent pasture, woodland, and farmstead. Roman numerals after the rotation symbols in this chapter refer to the land class to which the rotation applies. The following comparisons are made: (1) Changes in plans are presented for each management level as capital input varies. (2) Plans for the three management levels are analyzed at a common level of intensification to determine effects of improved management practices. (3) Effects of resource hiring on income are studied.

Profit Maximizing Plans

The amount of capital used in each of the plans is consistent with a specific level of intensification. Because of personal preferences or present net worth, operators tend to group themselves about certain of these levels. Among the more common levels are those in which no hired labor is used,

livestock is limited to building capacity, or feed grain consumption is balanced with production. To reach these levels, individuals can borrow or lend capital until their supply matches the amount required for one of the plans presented. Certain of the higher capital levels in each situation are not representative of actual farm conditions. These are presented as long as return on capital exceeds 5% out of academic interest. An operator would want to check alternatives not considered in this study (such as renting land) to determine if higher returns could be earned.

Low level management

Optimum plans for the Shelby-Grundy-Haig, low level management situation are shown in Table 17 and Figure 4.

Complete cropping with the most grain-intensive rotation permitted by soil conservation restrictions is the most profitable use of very limited capital. On both the level, productive Clarion-Webster soils and the hilly, poorer quality southern Iowa soils, limited capital is first used to crop the land. In neither case is livestock produced at the lowest capital levels. This pattern of crop farming at low capital levels and livestock farming with more capital available parallels what farmers actually do. Young farmers are typically limited in capital, and hence would be expected to raise fewer livestock than their more established neighbors. Even with good management practices, they cannot expect a

large income without a livestock program.

Fertilizer response is high on Class I and II soils, although the absolute yield levels are not so high as in the Clarion-Webster area. This fact indicates that even in the poorer soil areas, fertilizer for the Class I and II land gives high return on capital. Very little labor and production cost is added by fertilizing. Only cost of fertilizer need be balanced against marginal returns. For livestock production, a large capital investment in breeding stock and equipment would be required. Return per dollar input is lower than for fertilizer on Class I and II soils. However, livestock made the greater return than fertilizer on Class III land that is poorly managed.

Since only 78.6 acres are in grain with the most intensive rotation, labor supply remaining for livestock production is not severely limiting. Instead, returns to the limited building space available is a key factor in planning. The one litter hog system again returns most to limiting resources. Clarion-Webster plans indicated that one litter hogs maximized returns to limited capital and May-June labor. These plans show that the same enterprise is optimum with limiting building space, corn supply, and capital. In both cases, low capital input results in high return on each dollar from the one litter system.

Forage output from permanent and rotation pasture is

large with any of the permitted cropping arrangements. Cropping does not have to be adjusted to livestock production since grain is the more limiting feed and must be purchased at high capital levels. Hence, the most grain-intensive cropping is optimum at all capital levels.

The limited grain production restricts income severely with no livestock program. However, the small capital requirement leaves a large portion of a given capital supply for livestock production. One important point is apparent. The 160 acre farm in southern Iowa needs a livestock program to return greater than sustenance income to the operator.

Beef cows are not included at low capital levels even though there is a large amount of forage available. They have a high capital input relative to returns, and so hogs are more profitable even with building cost included. However, beef cows do not compete with hogs for corn or building space. When expanding the hog enterprise would require grain purchase, beef cows are included to consume the forage. The difference between the $1.20 selling price and $1.30 purchase price per bushel of grain is crucial. In this situation, the imputed value of corn fed to hogs housed in purchased buildings is within the $.10 per bushel range. It is more profitable to expand hogs with purchased buildings than to sell the corn and add a beef cow herd as capital is expanded. It is less profitable to expand hogs by buying corn and buildings

Table 17. Optimum Shelby-Crundy-Haig farm plans with low level management and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	753	1,291	$CCSb_0$ I	16.2		Land	+ 2,113	0
			$CSbCOM_0$ II	68.6				
			$CCOMM_0$ III	26.6				
2	3,494	2,943	$CCSb_2$ I	16.2		Bldg. space	+ 362	0
			$CSbCOM_2$ II	68.6				
			$CCOMM_0$ III	26.6				
			Hogs, one litter		24			
3	3,884	3,176	Same cropping system			Corn	0	0
			Hogs, one litter		24			
4	6,694	3,856	Same cropping system			Pasture	0	0
			Hogs, one litter		24	Hay		
			Hogs, one litter bldg. purchase		4			
			Beef cow, sell calf		14			
5	15,233	5,766	Same cropping system			May-June labor	- 3,880	0
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		46			
			Beef cow, sell calf		10			
6	18,731	6,470	Same cropping system			March-April labor	- 5,440	6
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		64			
			Beef cow, sell calf		9			

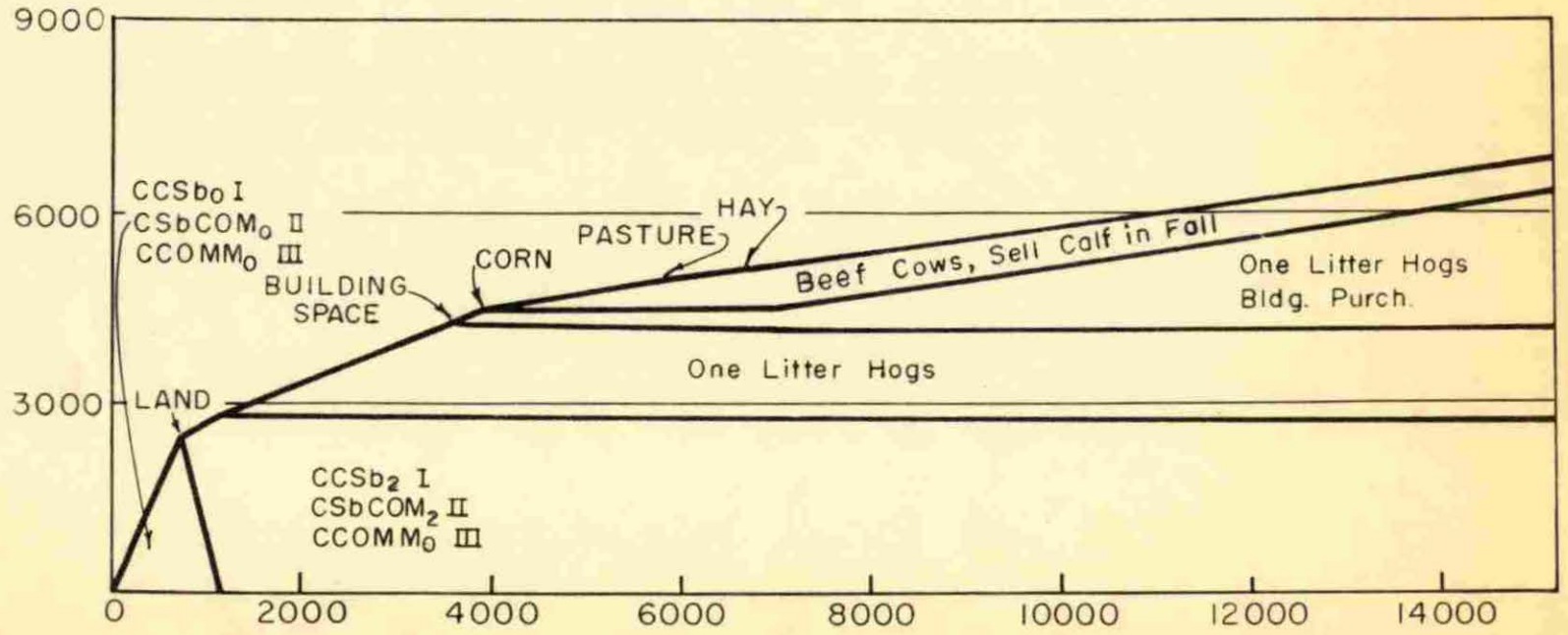


Figure 4. Optimum Shelby-Grundy-Haig farm plans with low level management and different quantities of capital available.

than to add beef cows to the plan. Because this difference in return is not large, the choice between beef cows and hogs expanded with building purchase might well depend on personal preference. After available forage has been consumed, there is no choice but to expand hog production.

At the $6,694 capital level, which is fairly typical of the area, both forage and grain production are completely utilized. Capital rationing may in some cases preclude further expansion of the farm business. The large capital input needed for purchasing hog buildings and feed grain would be hard for many low level managers to obtain even though available resources could be used more fully.

Return on capital is much lower than in the Clarion-Webster situation, where $6,695 returned $8,094. No amount of capital combined with the available resources will produce $8,094 in this situation. Two implications are apparent. First, the income potential from a 160 acre farm is much lower in southern than northern Iowa. Second, a larger operating capital supply is needed in poorer soil areas to realize the same income as do grain belt farms.

Average management

Several features of the maximum profit plans presented in Table 18 and Figure 5 are of interest. The most apparent point is that up to very high capital levels, the cropping pattern for average and low level management farms are

identical.

For a large portion of farms in the Shelby-Grundy-Haig area, crop production alternatives are limited. Large minimum forage production suggests as a first principle of management to "crop every acre as intensively as soil conditions will allow." This suggestion is relaxed when capital reaches $29,736. Class I land is shifted to $CCOM_2$ and Class III land is left idle to free labor for hogs. However, this capital level is more of academic than practical interest. The few operators who are this well financed would be older, established men who would prefer to seek other investment opportunities and use the labor released for leisure activities.

In this situation, the added $.10 per bushel required for grain purchase did not make beef cows more profitable than expanded hog production. The internal value of corn for hog feed in the plan is greater than $1.30 per bushel because of more favorable input-output ratios resulting from improved practices. Hence, hog production is further expanded and forage production is never completely used.

Again as a result of gains from improved livestock management, incomes are much higher than for low level managers. Usable capital input varies with the management level.

Table 18. Optimum Shelby-Grundy-Haig farm plans with average management and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	904	1,527	$CCSb_0$ I	16.2		Land	+ 2,247	0
			$CSbCOM_0$ II	68.6				
			$CCOMM_0$ III	26.6				
2	4,130	4,243	$CCSb_2$ I	16.2		Bldg. space	+ 552	0
			$CSbCOM_2$ II	68.6				
			$CCOMM_0$ III	26.6				
			Hogs, one litter		24			
3	5,203	4,812	Same cropping system			Corn	0	0
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		6			
4	20,508	9,207	Same cropping system			May-June labor	- 4,715	0
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		56			
5	25,468	10,546	Same cropping system			March-April labor	- 6,223	6
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		72			
6	29,736	11,306	$CCSb_2$ I	16.2		---	- 7,507	67
			$CCOM_2$ II	68.6				
			Idle land III	26.6				
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		87			

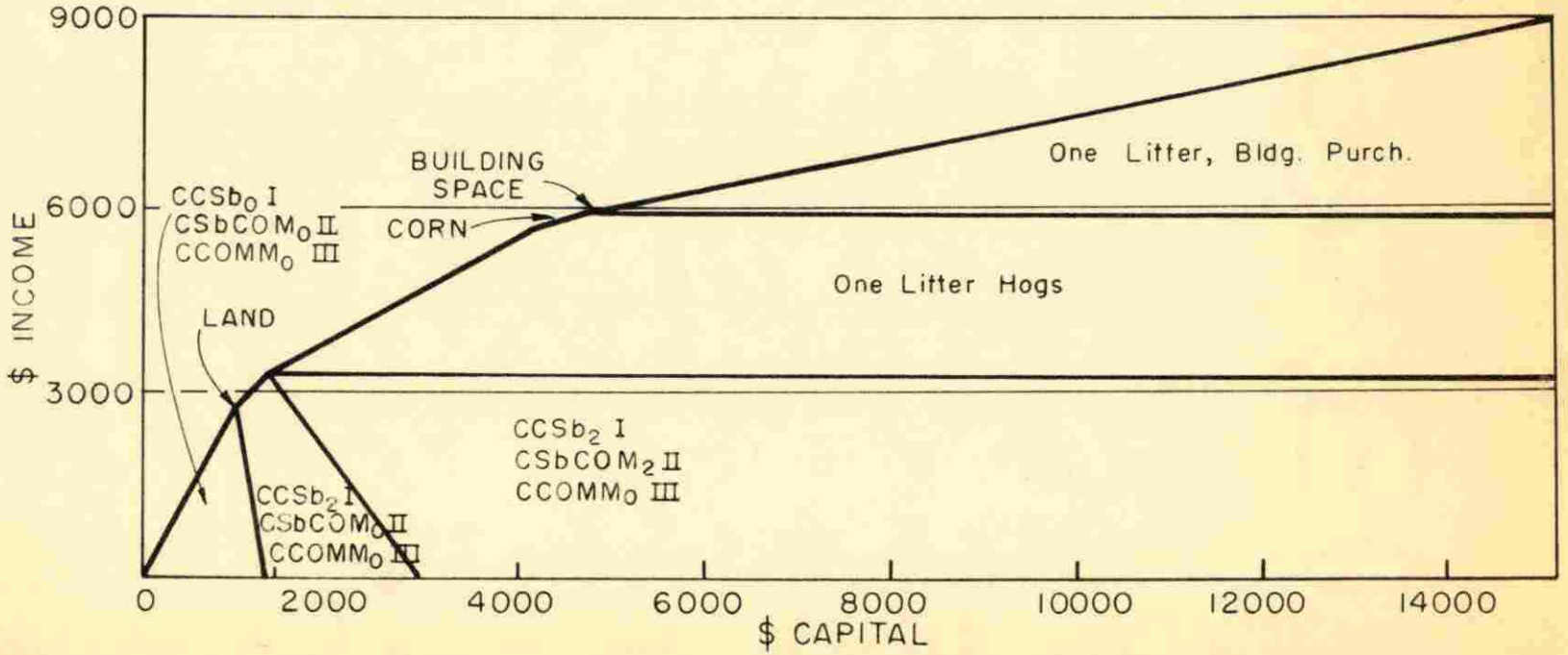


Figure 5. Optimum Shelby-Grundy-Haig farm plans with average management and different quantities of capital available.

Superior management

The plans presented in Table 19 and Figure 6 assume at least intermediate fertilization of all cropland. Significantly, the Class III land is cropped with a fertilized rotation before hog production is undertaken. Further, after building space has been filled by hogs, the Class III rotation is switched to high fertilization. At the two lower levels of management, Class III land was not fertilized at any capital level. Hence, in order for fertilization of poor land to be profitable, superior management practices are needed. This vindicates both farmers in the area and management specialists. Farmers typically claim that fertilizer does not pay on this land--which is true for two levels of management. Specialists have recommended fertilization practices for the land. Assuming the yield estimates are correct, the specialists are right in recommending superior management practices and fertilization together above intermediate capital levels.

A short fed yearling enterprise, which requires no building space, is used at the typical capital levels. Cattle are in the feedlot throughout the year which keeps capital productively invested. Good use is made of labor in months when it is plentiful and capital return is high. Hence, adding the enterprise is more profitable than buying buildings to expand hog production.

The superior manager does not experience the stability

of cropping pattern noted for average and low level situations. Better management practices make livestock production more competitive with crops for resources. Because fertilization is assumed, Class III land is first cropped with COM instead of CCOMM. Value of more corn for expanding cattle feeding prompts a change from CSbCOM to CCOM on Class II land at the $7,935 capital level. At the more academic levels above $26,509, intensity of rotation on Class I is reduced and finally Class III land is left idle. The labor is utilized in expanding hog production. Cropping the Class III land within the entire practical range of capital levels in all situations, even though crop yields are low, points up the relative scarcity of cropland.

Plans 8 and 9 are for practical purposes of academic interest only. Yet, the plans at first appear inconsistent. Adding a two litter system with building purchase instead of further expanding the one litter system does not appear to make economic sense. Why is the one litter system not expanded? The answer is that the supply of March-April labor is internally free to the firm. Expanding the one litter hog system to use all March-April labor would necessitate purchase of May-June labor. The two litter system returns more to the available March-April labor than would the one litter system when May-June labor has to be purchased. Reduction of the one litter system was necessary to provide enough May-June

Table 19. Optimum Shelby-Grundy-Haig farm plans with superior management and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	1,155	2,137	$CCSb_1$ I	16.2		Land	+ 2,850	0
			$CSbCOM_1$ II	68.6				
			COM_1 III	26.6				
2	4,639	5,799	$CCSb_2$ I	16.2		Bldg. space	+ 761	0
			$CSbCOM_2$ II	68.6				
			COM_1 III	26.6				
			Hogs, one litter		24			
3	6,694	7,405	$CCSb_2$ I	16.2		Corn	0	0
			$CSbCOM_2$ II	68.6				
			COM_2 III	26.6				
			Hogs, one litter		24			
			Yearlings, short fed		10			
4	7,935	8,022	$CCSb_2$ I	16.2		---	0	0
			$CCOM_2$ II	68.6				
			COM_2 III	26.6				
			Hogs, one litter		24			
			Yearlings, short fed		17			
5	12,163	10,088	Same cropping system			Hay	- 1,158	0
			Hogs, one litter		24			
			Yearlings, short fed		31			
6	17,340	12,215	Same cropping system			May-June labor	- 2,706	0
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		16			
			Yearlings, short fed		31			
7	22,604	13,666	Same cropping system			---	- 4,511	0
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		60			

Table 19. (Continued)

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
8	26,509	14,651	$CCOM_2$ I	16.2		March-April labor	- 5,948	0
			$CCOM_2$ II	68.6				
			COM_2 III	26.6				
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		48			
			Hogs, two litter bldg. purchase		12			
9	30,076	15,512	$CCOM_2$ I	16.2		---	- 7,459	0
			$CCOM_2$ II	68.6				
			Idle land III	26.6				
			Hogs, one litter		24			
			Hogs, one litter bldg. purchase		55			
			Hogs, two litter bldg. purchase		13			

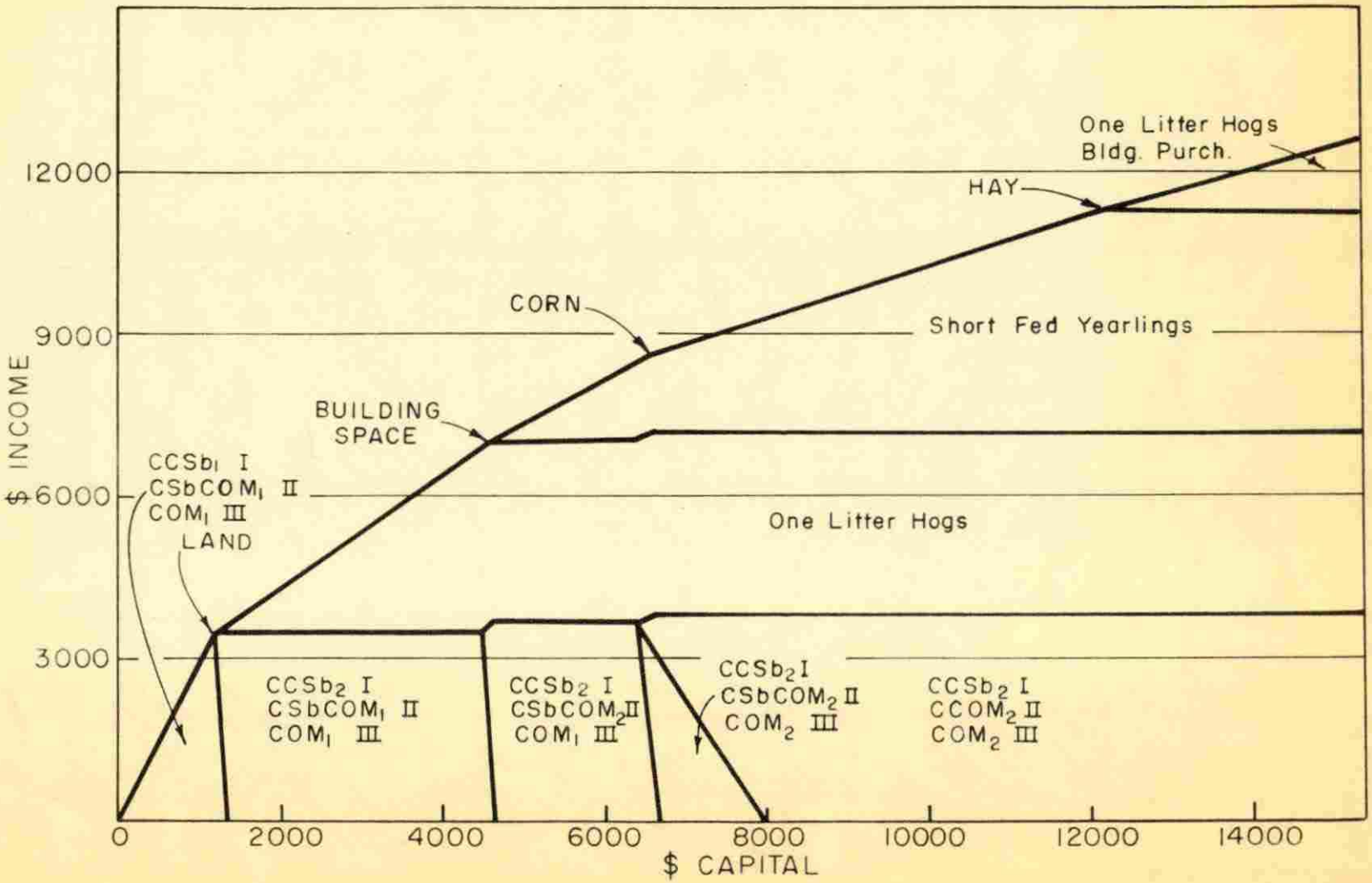


Figure 6. Optimum Shelby-Grundy-Haig farm plans with superior management and different quantities of capital available.

labor for the two litter enterprise.

Effects of Improved Overall Management

Various management implications and suggestions have been included in the above discussion. However, this subject is of great practical importance in solving short run farm income problems. It is explored further at this point. Table 20 reproduces plans at the three levels of management for two commonly found resource use situations. These are (1) entire grain production fed to livestock and (2) no labor hired. In these situations, few crop acres and non-intensive permissible rotations result in low crop labor requirements. Hence, in contrast to the Clarion-Webster area, feed grain is more limiting than May-June labor supply.

Feed all grain produced

Because of the importance of livestock, management return is high even in this limited capital situation. Conditions do not approach the "other things being equal" status that would be ideal to compare management effects. Capital input varies from $3,884 to $6,694 to feed all grain production. However, these usable levels are the result of a common acreage of feed grains. Hence, if (as suggested) operators tend to group themselves around such degrees of intensification, this comparison is meaningful. Superior managers are able to

realize over twice as much income as low level operators who have the same intensity preference. Their capital inputs are much higher because more efficient feed conversion by hogs leaves grain for cattle feeding. Cost of feeder cattle adds to capital requirements. This implies that one of the fruits of better management is risk reduction through diversifying production without deviating from profit maximization.

Use all May-June labor

The extensive livestock program needed to use May-June labor uses the building purchase alternative extensively. Hence, capital requirements at this intensity are higher than amounts typically available of southern Iowa farms, and average return to capital is lower than for a similar amount of operating capital in the Clarion-Webster area. However, returns to fixed capital does not show this pattern because of the much higher land values in northern Iowa. Net returns again are reflective of the productivity of livestock management.

Since the Shelby-Grundy-Haig area is classified as a pasture region, it would presumably follow that beef cows would be an important enterprise. However, only the low level managers keep beef cows to utilize the roughage produced. Prevalence of beef herds in the area may be explained by internal or external capital rationing which has negated expansion of the hog enterprise by building purchase. Results

Table 20. Comparison of certain optimum Shelby-Grundy-Haig farm plans at different management levels for farm types.

Characteristic and item	unit	Management: Low level		Average		Superior	
Feed all grain produced							
Net return	$		3,176		4,812		7,405
Capital used	$		3,884		5,203		6,694
Enterprises	acres	$CCSb_2$ I	16.2	$CCSb_2$ I	16.2	$CCSb_2$ I	16.2
	acres	$CSbCOM_2$ II	68.6	$CSbCOM_2$ II	68.6	$CSbCOM_2$ II	68.6
	acres	$CCOMM_0$ III	26.6	$CCOMM_0$ III	26.6	COM_2 III	26.6
	units	Hogs, one litter	24	Hogs, one litter	30	Hogs, one litter	24
Use all May-June labor							
Net return	$		5,766		9,207		12,215
Capital used	$		15,233		20,508		17,340
Corn bought	bu.		3,880		4,715		2,706
Enterprises	acres	$CCSb_2$ I	16.2	$CCSb_2$ I	16.2	$CCSb_2$ I	16.2
	acres	$CSbCOM_2$ II	68.6	$CSbCOM_2$ II	68.6	$CCOM_2$ II	68.6
	acres	$CCOMM_0$ III	26.6	$CCOMM_0$ III	26.6	COM_2 III	26.6
	units	Hogs, one litter	70	Hogs, one litter	80	Hogs, one litter	40
	units	Beef cow, sell calf	10			Yearlings, short fed	31

indicate that this may not be a rational decision in average management situations.

Cattle feeding loans are somewhat more available for the superior manager, and plans show that the short fed yearling enterprise is a profitable alternative. It was not permitted for other management levels because of the management skills required. The very different livestock programs called for at the three management levels reflect changes in the relative productiveness of enterprises as the management input is increased.

Effects of Resource Hiring

Levels of resource hiring are indicated in the previously presented tables. In general, the amount of a resource purchased depends on the management level. Whether or not it is purchased at all depends on the soil area.

No labor is hired at the typical capital levels in southern Iowa, since other resources are more restricting. This also suggests that the opportunity for hiring out as part time farm labor to add to income is not an alternative for operators in the area.

Table 20 comparisons show the importance of building and feed grain purchase. The average manager buys buildings to get enough livestock volume to feed all grain, and the superior operator goes to cattle feeding because of shortage of

building space. At the higher capital level, building purchase is profitable at all management levels. In these situations, 2,706 to 4,715 bushels of grain and 16 to 56 units of building space are purchased. Fuller use of other available resources raises net returns in proportion to the management input.

CHAPTER VII: OPTIMUM PLANS WITH OUTSIDE AID FOR MULTIPLE HOG SYSTEMS

Primary interests in the plans presented in Chapters V and VI were with (1) the most profitable hog systems in several situations, and (2) methods of intensifying hog production as capital supply of a farm increases. Permissible systems depended on the management skill required. Low level managers could choose between one and two litter systems. Average managers had the added alternative of a four litter enterprise. One, two, four, and six litter systems were choices for the superior manager. Any of the systems could be intensified by purchasing additional buildings. Since the multiple hog systems always required some building purchase, capital input was relatively high. One and two litter enterprises require the larger capital input only after available building space was used. These enterprises represent production opportunities available to any operator in selecting a farm organization. Various comparisons presented suggest adjustments and gains from general improvement in management or from added capital made available to the farm in general.

Firms interested in vertical integration of hog production have offered more specialized forms of capital and management aid. This aid is available only in the production of four or six litter hog systems. Use of this outside help can raise the management level of a multiple hog system above the

general management used on the farm. Specific capital earmarked for multiple hog systems can leave the operators capital supply available for expansion of any other enterprise. It is hypothesized that such forms of aid can cause the multiple hog systems to become optimum in some of the farm situations studied. This chapter is devoted to analyzing the implications of specialized capital and management aid in farm planning.

Effects of Management Aid

In the situations analyzed in Chapters V and VI, the four and six litter systems were not so profitable as conventional hog enterprises produced with the same management practices. Return on resources must be increased for the multiple hog systems to become optimum in any of the situations. Improved management, which produces a larger output from given resources, is one possible method of increasing resource returns from the multiple hog systems.

The maximum improvement would be for the low level manager to produce superior management results with a four or six litter system. Either of two factors might cause such an improvement: (1) management aid provided by "package plans" such as those suggested by integrating firms, or (2) the possibility that, after deciding to operate a multiple farrowing system, the operator concentrated on adopting improved hog

management practices.

Will management aid produce resource returns for multiple hog systems that are greater than those to conventional systems without such aid? Low level management situations in each soil area were used for empirical study. Because of risk provisions, building purchase was not allowed for the one and two litter systems. The four and six litter systems for superior management were included. Hence, the situation provides a comparison most favorable to inclusion of the multiple hog systems. Optimum plans for each soil area will be presented.

Clarion-Webster plans

Table 21 and Figure 7 show optimum plans when management aid is provided for the multiple hog systems. In the following discussion, comparisons will be made with plans for the same situation without management aid (see Table 13).

The plans are identical through the $3,604 capital level. Cropping, fertilization, and the one litter hog enterprise return more to very limited capital and May-June labor than do superior managed multiple hog systems. One question is already partially answered. Management aid cannot sufficiently increase resource returns from the multiple hog systems so that they are most profitable when capital is very limited. Net return of $6,816 using only family labor and a one litter hog enterprise would seem satisfactory to many operators.

At higher capital levels, May-June labor must be hired in

order to expand the livestock program. Labor hiring is a cash cost, but other labor not fully used at lower capital levels is internally "free" to the firm. Thus, it is most profitable to expand the livestock enterprise which productively used the largest bundle of this "free" labor per hour of May-June labor which must be hired. A six litter system best fits this specification because its labor requirement is distributed over the entire year. The $11,129 return from 8 units (24 sows) allowed by March-April labor supply is higher than can be earned from use of the one litter system in the low level management farm situation.

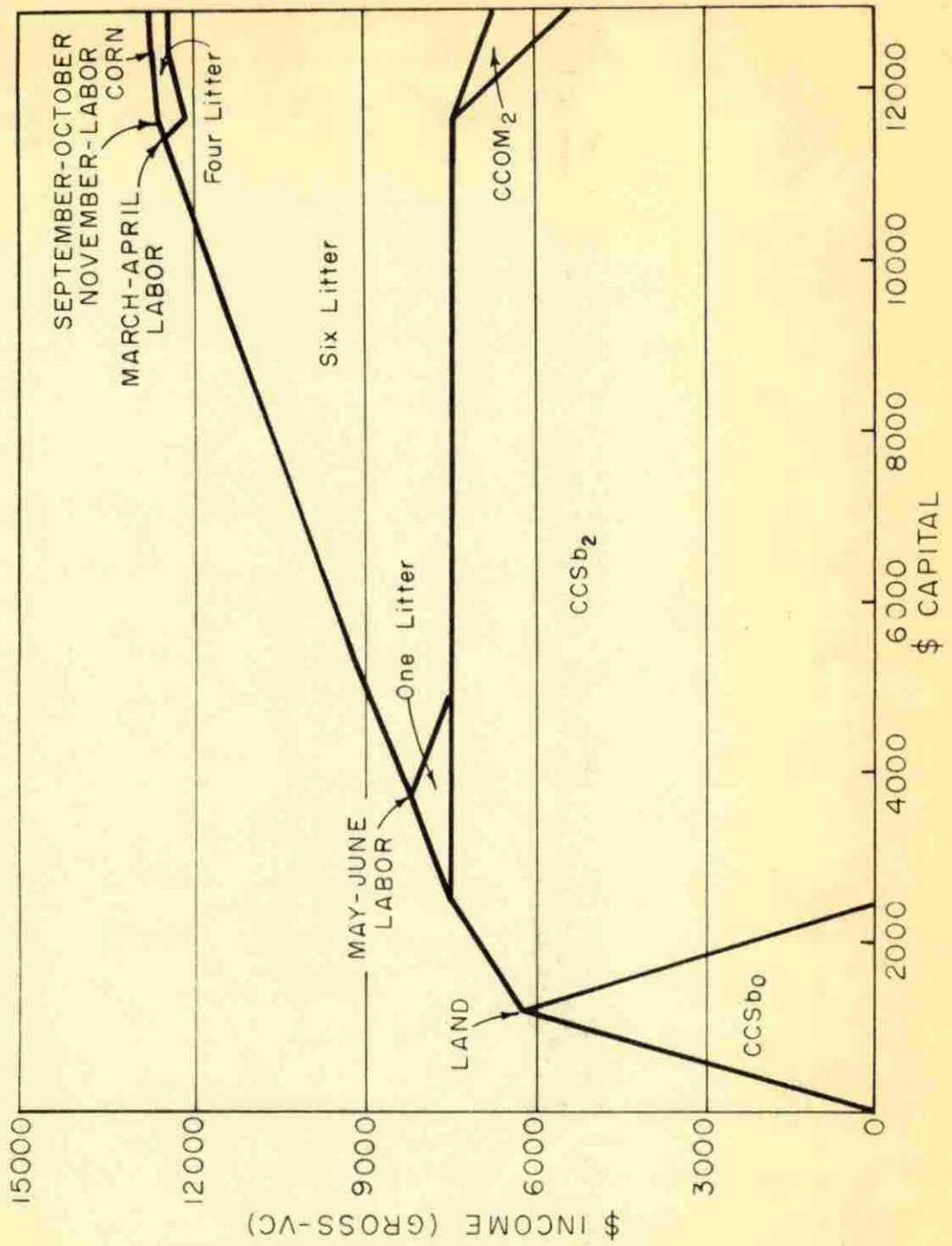
A final intensification gives a plan which used all labor in March, April, May, June, September, October, and November. Crop intensity of 41.6 acres is reduced to $CCOM_2$, even though unneeded forage is produced. The March-April labor freed allows expansion of the six litter system to 9 units and addition of one unit of the four litter system. Less labor is hired because crop requirement is reduced.

The four litter unit is added to a six litter enterprise because it has a low May-June labor input. Hence, only a minimum of March-April labor is taken from the six litter enterprise to allow complete use of fall labor. The two systems combine in the following manner: 10 sows are kept to farrow on the January-July schedule, 10 sows on the March-September schedule, and 9 sows in May-November plan for a

Table 21. Optimum Clarion-Webster farm plans with low level management, superior management for four and six litter systems, and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	1,177	4,798	$CCSb_0$	150.3		Land	+ 4,259	0
2	3,604	6,816	$CCSb_2$	150.3		May-June labor	+ 5,145	0
			Hogs, one litter		12			
3	11,514	11,129	$CCSb_2$	150.3		March-April labor	+ 1,093	120
			Hogs, six litter		8			
4	12,992	11,563	$CCSb_2$	108.7		Corn	0	92
			$CCOM_2$	41.6		Sept.-Oct.-Nov. labor		
			Hogs, six litter		9			
			Hogs, four litter		1			

Figure 7. Optimum Clarion-Webster farm plans with low level management, superior managed four and six litter hog systems, and different quantities of capital available.


$ INCOME (GROSS-VC)
15000
12000
9000
6000
3000
0
2000
4000
6000
8000
10000
12000
$ CAPITAL
SEPTEMBER-OCTOBER
NOVEMBER-LABOR
CORN
MARCH-APRIL
LABOR
Four Litter
Six Litter
One Litter
MAY-JUNE
LABOR
LAND
CCOM2
CCSb2
CCSb0

total of 58 litters per year. This combination demonstrated that strict adherence to a single system is not always profit maximizing. Given a very limited labor supply, it is more profitable to leave some facilities idle for a part of the year than to leave some labor unused in order to keep a set of buildings filled to capacity.

Comparison of highest capital plans in Tables 13 and 21 show the maximum possible gain from management aid and the added $2,017 of operating capital required. Each plan used all spring labor, but the multiple hog systems also use the entire fall labor supply. One gain from the management aid (hence a gain from use of the multiple hog system) is fuller use of labor throughout the year. Productivity of management practices is shown by the $3,685 higher revenue from an added $2,017 capital, 43 hours less hired labor, and less feed grain purchased.

Shelby-Grundy-Haig plans

This section discusses the management-aid plans presented in Table 22 and Figure 8. They are compared with plans in Table 16, which are for the same situations without the management aid. Again, management aid does not adapt the multiple hog systems to limited capital situations. The following uses return more to restricting resources when capital is very limited: (1) cropping land with the most grain-intensive rotation permitted, (2) fertilizing rotations

on Class I and II land, and (3) producing hogs to limits of building capacity with the one litter system.

There is a relatively large amount of labor available in all months for livestock production. This supply is most limited in the May-June period. The four litter system is used in preference to any of the other livestock enterprises because its labor requirement pattern most nearly fits the remaining supply available in the various months. Hence, returns to corn, building space, and capital are also maximized.

Seven units of the four litter system use all available building space for nursing-growing-fattening facilities. Farrowing quarters and sow shelters for these units must be purchased. Complete building purchase is required for all units in excess of seven. Thus, capital input increases rapidly when the multiple hog system is used. In order to use available May-June labor, $32,472 capital is required. The maximum capital plan uses $38,132 capital and also remaining March-April labor. It is doubtful whether an individual low level manager who improved his own management practices on multiple systems would have this amount of capital available. Hence, plans at lower capital levels would be the maximum considered. Possibly an integrating firm providing management aid would also assist in obtaining some capital. This, too, would probably fall short of the levels indicated in the last three

plans presented. Hence, they are primarily of academic interest.

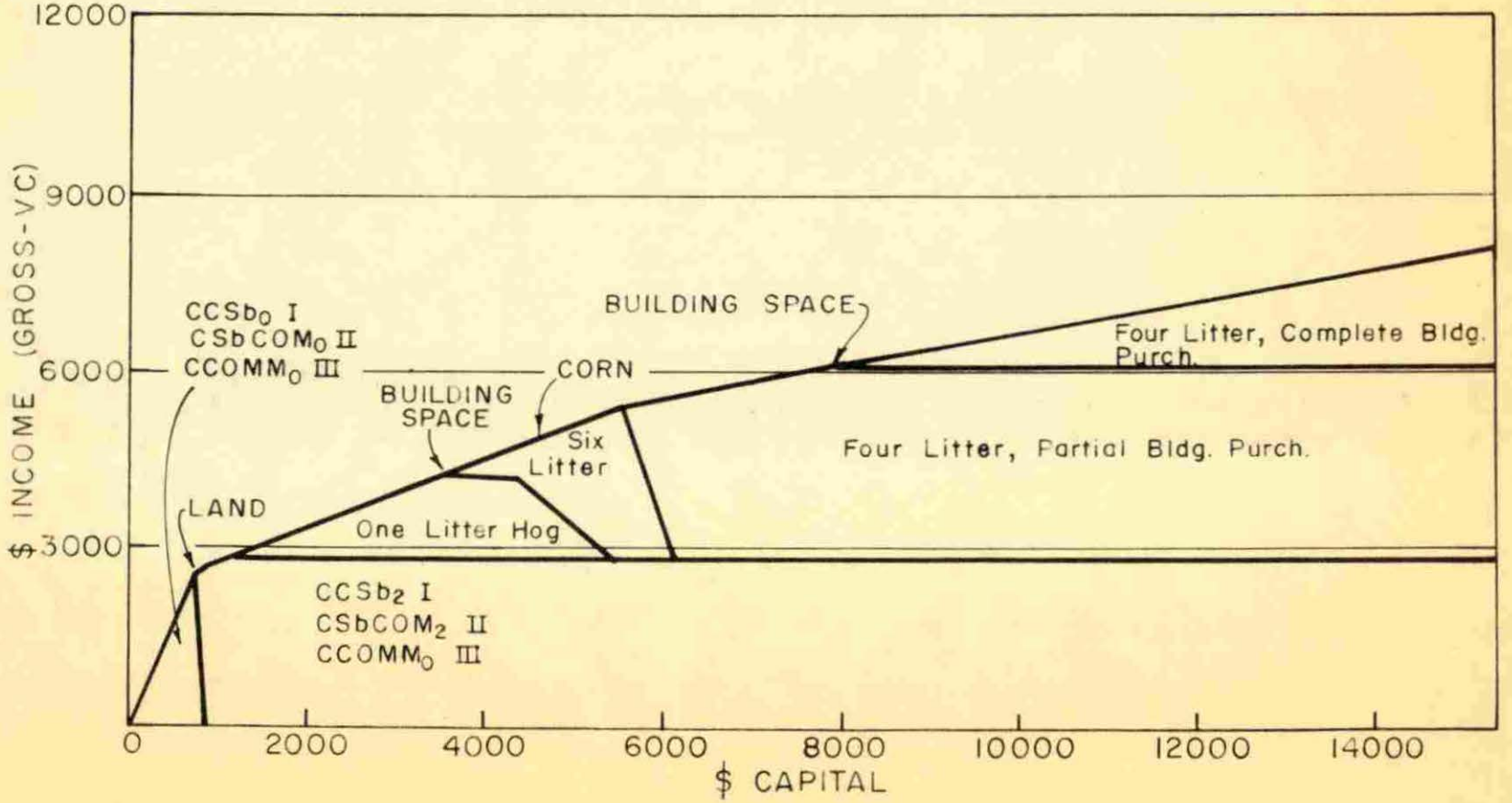
Stability of the optimum cropping plan was noted in Table 16. It is not a feature of the plans which include multiple hog systems. The most intensive cropping is optimum until high capital levels. At this point, the four litter system expanded by building purchase requires additional May-June labor. Crop intensity is reduced on Class II and III land, and at the $38,132 capital level Class III land is left idle to free labor for the hog enterprise. Hence, the imputed value of the labor in crop production on Class II and III land is less than the $1.10 per hour hiring cost. Since grain is purchased in both cases, the cost of grain produced by the rotation, in terms of hog production sacrificed, is greater than $1.30 per bushel purchase price.

Management aid for the multiple hog system allows a much greater income and a higher profitable capital input. Twenty-seven units (108 litters) of the four litter system are raised under the maximum capital plan. Returns are $12,873, or almost double the $6,470 possible without the management aid. Since the very high capital requirements are not realistic for many situations, operators would not be generally able to reach this income level. With amounts of capital which might reasonably be expected, spring labor is not completely used, but the supply in other months would be used more fully than

Table 22. Optimum Shelby-Grundy-Haig farm plans ~~with low level management~~, superior managed four and six litter hog systems, and different quantities of capital available

Plan	Capital level $	Net return $	Enterprise	Level Acres	Level Units	Additional resource limiting	Corn surplus or deficit	May-June labor hired
1	753	1,291	$CCSb_0$ I	16.2		Land	+ 2,113	0
			$CSbCOM_0$ II	68.6				
			$CCOMM_0$ III	26.6				
2	3,494	2,943	$CCSb_2$ I	16.2		Bldg. space	+ 362	0
			$CSbCOM_2$ II	68.6				
			$CCOMM_0$ III	26.6				
3	6,035	4,310	Same cropping system			Corn	0	0
			Hogs, four litter		6	(Bldg. space not limiting)		
4	8,061	4,927	Same cropping system			Bldg. space	- 629	0
			Hogs, four litter		7			
5	32,472	11,627	Same cropping system			May-June labor	- 7,457	0
			Hogs, four litter		7			
			Hogs, four litter bldg. purchase		16			
6	33,257	11,806	$CCSb_2$ I	16.2		March-April labor	- 7,405	0
			$CCOM_2$ II	68.6				
			$CCOMM_0$ III	22.9				
			$COMM_0$ III	3.7				
			Hogs, four litter		7			
			Hogs, four litter bldg. purchase		17			
7	38,132	12,873	$CCSb_2$ I	16.2		---	- 9,653	0
			$CCOMM_0$ II	30.2				
			$CCOM_2$ II	4.4				
			$CSbCOM_2$ II	24.0				
			Idle land III	26.6				
			Hogs, four litter		7			
			Hogs, four litter bldg. purchase		20			

Figure 8. Optimum Shelby-Grundy-Haig farm plans with low level management, superior managed four and six litter hog systems, and different quantities of capital available.


12000
9000
6000
3000
$ INCOME (GROSS-VC)
CCSb0 I
CSbCOM0 II
CCOMM0 III
CORN
BUILDING SPACE
BUILDING SPACE
Four Litter, Complete Bldg. Purch.
Six Litter
Four Litter, Partial Bldg. Purch.
LAND
One Litter Hog
CCSb2 I
CSbCOM2 II
CCOMM0 III
0
2000
4000
6000
8000
10000
12000
14000
$ CAPITAL

with conventional hog systems. Hence, use of the multiple hog system allows a higher income with any level of resource use.

Effects of Capital Lending

Results presented in Chapters V and VI suggest that a high capital requirement may preclude use of the multiple hog systems. Will the availability of loaned capital earmarked for the four or six litter systems make them optimum in typical farm situations? The special loans may be available for either of two reasons: (1) Integrating firms may provide special credit provisions or assist an operator in obtaining outside credit. (2) Commercial agencies may be willing to lend to individual operators only for expansion of a multiple system.

Optimum plans for a discrete capital level were computed with the superior management situation in each soil area. Levels chosen were $8,895 for Clarion-Webster and $6,694 for Shelby-Grundy-Haig. Farm records indicate that, of the levels in Tables 15 and 19, these are most "typical" of the areas.

The lending provision was included in this manner: Capital requirement for multiple hog systems was reduced to the cost of buildings and equipment. It was assumed that an outside source would loan operating capital for breeding stock and cash expenses. The money would be repaid at the end of the year with 6% interest charge. Net return was reduced by

amount of the loan plus interest. The situation chosen was most favorable to multiple farrowing in two ways: (1) The superior manager has the highest return on capital. He can most nearly be expected to realize a profit above the 6% interest charge. (2) The outside source provides a large portion of the capital input required. Much of the operator's capital supply is available for other uses.

The optimum plans for these capital lending situations were the same as those in the same situations without a lending provision (Plan 4, Table 15 and Plan 3, Table 19). Availability of specialized credit did not make the multiple hog systems optimum at the typical capital levels. A possible explanation for the result is this: In both plans for the "typical" capital levels, available building space was fully used, but no building purchase was included. Adding a multiple hog system would require some building purchase. This increased capital input and the interest charged reduced return on capital from the multiple systems. The one litter system, with no building purchase to reduce return on capital, provided a greater return to all limiting resources.

With increased capital supplies, the one litter system would require building purchase. This system used buildings much less intensively than the multiple enterprises. Hence, it is possible that at higher capital levels, the credit provision would cause the multiple hog systems to be optimum.

But, it has been shown that these systems, even with special credit available, are not profit maximizing at typical levels.

Implications of Aid Provisions

Capital or management aid as a basis for multiple hog systems was examined in this chapter. It was pointed out that the aid might be from integrating firms. Alternatively, operator effort to use better management practices with multiple hog systems could result in reduced capital rationing. Some general implications of the empirical results will be discussed in this section.

It was shown that management and capital are often technical complements in increasing farm income. Integrating firms have provided a bundle of technological information which often helps the farmer obtain capital from commercial agencies. They also may offer special credit provisions. Individual effort of the farmer takes the form of obtaining and using management suggestions from Extension agencies. Agricultural Extension Services furnish only management aid. Since suggested practices are frequently not linked to previous recommendations, farmers may have difficulty in interpreting and coordinating them. Hence, lending agencies do not increase amounts of capital available to farmers. Relating management practices to previous suggestions, and other efforts to reduce credit barriers, may be needed in

Extension work.

Beginning farmers and others who most need increased income usually have very limited capital. Multiple hog systems are not adapted to these limited capital situations because they require a relatively large investment in buildings. Even with management aid offered, potential income increases are not large when capital is limited. Use of the multiple hog systems would become optimum in many of these farm situations, if it were the only way of obtaining the added capital. The total operator and outside capital supply would need to exceed minimum levels for multiple hog systems suggested in Tables 21 and 22.

Recognizing the complementarity of capital and management in this situation is especially important in solving their income problem. At higher operator capital levels, management aid alone made the multiple hog systems optimum. Full use of available labor and buildings and favorable input-output ratios favor the multiple systems. The specific situation studied assumed maximum management contribution, but results suggest that a combination of capital and management would reduce the management contribution needed.

It is not necessary that either multiple hog systems or management and capital aid require integration plans. As was pointed out, concentration on hog management by an individual operator or eased credit restrictions could make the multiple

hog systems optimum. Thus, gains shown are not an exclusive product of integration. They are a result of the practices used in connection with integration. There is no basic reason that these practices cannot be provided by other sources.

Choice among multiple farrowing systems should depend on the resources available and their alternative used. A single system is not exclusively optimum in all soil areas, or even for a given farm. If alternative use of labor produces a high return in certain months, labor can be purchased profitably for hogs and the more intensive systems used. Low labor return from alternative uses suggests a less intensive system which uses a maximum of other resources in combination with each hour of restricting labor. Results show that fullest use of resources is also the critical factor on an individual farm. Combining two systems to make fullest use of limited labor in a 160 acre situation proved more profitable than leaving labor idle in order to keep purchased buildings used to capacity in all periods of the year.

CHAPTER VIII: SUMMARY AND CONCLUSIONS

This study probed the adaptation of alternative hog systems to 160 acre farms. It was designed to compare the conventional one and two litter pasture systems with concrete confinement four and six litter systems. The multiple farrowing systems have attracted interest mainly since the advent of vertical integration in swine raising. They could be adopted by an individual farmer with or without help from an integrator. The operator could retain the same production methods used with conventional hog systems, or he could use better methods when multiple farrowing. Therefore, comparisons were made with and without specific forms of aid provided for the multiple hog systems. The capital or management aid considered could be provided by business firms, Agricultural Extension Services, or by added effort from the farm operator.

Variable capital linear programming solutions were developed in the Clarion-Webster and Shelby-Grundy-Haig soil areas at three management levels. Representative crop rotations at two alternative fertilization levels and typical beef producing enterprises were considered as production alternatives. However, main emphasis was placed on choice among one, two, four, and six litter hog systems. Each hog system could be expanded with purchase of buildings and equipment. Grain purchase and sale and May-June labor hiring were also considered. Various comparisons among the basic optimum

plans indicate the effects of improving overall farm management or of making additional capital available to the firm.

Effects of specialized capital and management aid for the multiple hog systems were examined in the following manner. First, farms at the low management level were given superior management four and six litter hog systems as production alternatives. Comparison of these plans with those assuming no management aid were made. Second, superior management situations were recomputed making special capital lending provisions available to the multiple hog systems. It was hypothesized that both comparisons gave the outside aid opportunity to make the maximum possible contribution to income. Hence, these comparisons were most favorable to the multiple hog systems.

Analysis of the optimum plans indicated that planting all cropland to the rotation producing the greatest capital return was most profitable in all situations with very limited capital. Expenditure for fertilizer had a high priority, except on the Class III Shelby-Grundy-Haig soil. Average return from high level fertilization was greater than from livestock. However, the marginal return in going from intermediate to high level fertilization was nearly the same as from livestock production. These results demonstrate diminishing returns to fertilizer increments as the rate of application is increased. As capital supply was expanded in each situation, forage

producing rotations replaced the high cash return grain cropping to provide needed forage and to free labor for livestock production.

The one and two litter hog enterprises were more profitable than the multiple hog systems produced at the same level of efficiency. The one litter system dominated the optimum plans because it had a very low capital requirement (hence, high return on capital input) and it used limited spring labor efficiently. Labor supply in the Clarion-Webster situations and building space on Shelby-Grundy-Haig farms usually limited livestock expansion. Hence, building purchase and labor hiring were profitable alternatives at high capital levels. No cattle enterprises were used in the Clarion-Webster situations because of the high opportunity cost of producing forage. In southern Iowa, low level managers kept beef cows at intermediate capital levels and superior managers had a short fed yearling enterprise. The cattle enterprises were more profitable than hogs when buildings and corn had to be purchased for expansion of the hog enterprise.

When outside management aid was provided for the multiple hog systems, they became optimum above intermediate capital levels. The four litter system was used in southern Iowa because the necessary corn and building purchase drove the returns very low on enterprises requiring labor hiring in May and June. Requirement for labor hiring was less with four

than with the six litter system. Clarion-Webster farms had to purchase buildings, but not corn. Returns were not greatly reduced to enterprises requiring labor hiring. Thus, the six litter system was used, and labor hired. A combination of four and six litter systems was optimum at high capital levels. Maximum returns from limited labor rather than fullest use of building space was optimum in planning. Hence, a single multiple farrowing system cannot be the "a priori" recommendation for all farms or even for a single farm. Fuller utilization of available labor was a demonstrated advantage of the multiple hog systems. Income was higher than for the same situation when no management aid was provided. Capital lending provisions did not make the four or six litter enterprises optimum at typical capital levels.

In each soil area, income varied directly and significantly with the management level. Differences became more pronounced at high capital levels, where the effects of higher crop yields and more efficient livestock production were compounded. Hence, general management aid can provide an important tool in solving low income problems; it is especially effective if added capital is made available. Crop production could provide a larger than sustenance income in Clarion-Webster situations, but a livestock program was necessary in southern Iowa.

This study has considered some of the alternatives open

to operators of 160 acre farms. Other alternatives exist. Use of larger machinery to free labor for livestock production, hiring year-round labor, renting land, and taking non-farm work are examples. These are subjects for further study.

Any farm planning study would be incomplete without a plea for much work in developing more and better basic input-output data. This voice is added to the chorus.

APPENDIX A: PRODUCTION PRACTICES ASSUMED

Profit is the final measure of a successful manager. Efficiency and a large output are its causes. These factors are in turn a reflection of the production practices used. However, there is no one unique combination of practices which will in all cases yield a predetermined level of efficiency, of output, and hence of profit. There are ordinarily several such combinations. Yet, definition of practices is necessary to provide the technical experts a basis for furnishing reliable input-output relationships. Such definition is especially pertinent when more than one management level is being considered.

The following sets of practices were defined. Assistance was gained by reference to several sources (1, 2, 3, 4, 10, 11, 16). The list is not exhaustive; neither is it a blueprint. It should suggest, rather than limit, the mental picture. The pattern is intended to be typical of the average of the upper, middle, and lower third of managers on Cornbelt farms.

Crop Management

Superior management

1. Use recommended crop varieties only.
2. Complete weed control--cultivation, tillage, and herbicides--practiced.

3. Oats and seed corn treated; legumes inoculated; corn rootworm, corn borer, and grasshoppers controlled.

4. Timeliness optimum--all operations done at the "right" time.

5. Planting rates adjusted to soil capability--approximately as follows: corn--16,000 plants per acre, oats--1½ bushels per acre, soybeans--1 bushel per acre, alfalfa-brome mix--15 pounds per acre.

6. Planting depth optimum.

Average management

1. Recommended varieties used.

2. Weed control included only limited use of herbicides.

3. Oats and corn seed treated; legume inoculated; corn borer and grasshopped controlled.

4. Most operations within allowable range of timeliness, but not necessarily at the optimum point.

5. Planting rates per acre approximate the following, depending on soil capability: corn--12,000 stalks, oats--1½ bushels, soybeans--1 bushel, alfalfa-brome mix--15 pounds.

6. Optimum planting depth used.

Low level management

1. Use some early and late maturing corn; older varieties of oats, soybeans, and legumes may be used.

2. No herbicides used in weed control.

3. Corn treated; legume seed inoculated; grasshopper controlled.

4. Some land plowed wet; late corn cultivation; hay cut after mature.

5. Per acre planting rates approximate the following: Corn--9,000 stalks, oats--uncleaned seed at 1½ bushels, soybeans--3 pecks, alfalfa-brome mix--12 pounds.

6. Planting depth by random, rather than scientific, choice.

Feeder Cattle Management

Superior management

1. Carefully selects thrifty feeders; get them on feed without setback.
2. Provide adequate salt, shade, and water; control flies.
3. Regular and quiet in feeding.
4. Get cheap gains by using waste roughage in fall.
5. Keep cattle out of mud.
6. Discover and treat sick animals early.

Average management

1. Off-hours feeding during busy seasons.
2. Water tank empty or frozen over occasionally.
3. Less careful selection of feeders; a few poor doers.
4. Major health problems controlled.

Low level management

1. Buys feeders graded higher than they are, less selective.
2. Cattle go off feed after major ration change; salt, feed, and water not always available.
3. Irregular hours, noisy in feeding.
4. Seldom sprays flies; some muddy lots.
5. Feeds less adequate ration.

Beef Cow Management

Superior management

1. Saves calves from best cows for replacements; 90% calf crop, 400 pound calves weaned.
2. Thrifty, beefy sires used.
3. Shade, salt, water provided at all times; flies controlled.
4. Health of animals watched and treatment provided where needed.

Average management

1. Calf crop 80%.
2. No fly control; salt and water run out occasionally.
3. Average sire and health care.

Low level management

1. 70% calf crop.
2. Other practices less complete: late castration, weedy pasture, etc.
3. "Sale barn" sires, cattle neglected.

Swine Management

Superior Mgt.

1. Farrowing dates correspond to getting pigs on peak markets; pigs marketed at 5 months of age.
2. Exercise and adequate sow ration to help insure large litters; protect sows from accidents due to high door sill, mud, or butting by cattle.
3. Hold down death loss of baby pigs. Farrowing crates of pens with guard rails used. Sows selected partly on gentle temperament, and not carried in overfat condition. Heat lamps or cooling provided as the weather dictates. Anemia controlled. Milk supply of sows supplemented with

hand feeding and shifting pigs among litters.

4. Use definite meat type boars and select breeding stock from production records.

5. Keep pens light and clean to prevent scours; castrate, vaccinate, and ear notch at early age; creep feed pigs.

6. After weaning, pigs kept sanitary and uncrowded; control mange and insects; provide shelter, shade, and hog wallows; feed adequate rations; worm pigs.

7. Keep records as an aid to future management decisions.

Average management

1. Farrow 15 to 30 days later; pigs marketed at 6 months of age.

2. Mostly adequate rations fed; feeders occasionally run empty.

3. Some poor mothers among sows; hence more pigs crushed, fewer farrowed; some pigs hand fed, but more attention at farrowing time could be used.

4. Meat type boars used.

5. Pigs castrated and vaccinated before weaning, but not on early and definite schedule.

6. Some muddy lots and worm trouble.

7. Scanty records.

Low level management

1. Farrowing not at a time to gain top market prices; pigs marketed at 7 months of age.

2. Low protein to corn ratio in ration.

3. Factors such as mud, high door sills, and running in cow lots affect average litter size.

4. Minimal attention at farrowing. Heat lamps may be used, but guard rails, farrowing crates, or summer ventilation absent. Pens not well cleaned ahead of time and often

allowed to become dirty or poorly bedded. Pigs expected to survive on sow milk until weaned. Chilled pigs, anemia, flies, and mange occur.

5. No systematic castration or vacination. These jobs done when no other work pressing.

6. Poor quality rotation pasture or bluegrass, or old lots used for fattening hogs. Mudholes and wormy conditions on occasion; waterers and feeders may become empty or rancid.

7. Records a matter of memory.

8. Lardy hogs, selection of gilts from last of fattening lot practiced; boars purchased from any low cost source.

APPENDIX B: BASIC INPUT-OUTPUT DATA

This section includes the basic input-output relationships estimated on the basis of the practices defined in the previous section.

Estimates of resource requirements and production were obtained from published and unpublished reports of agricultural experiment stations of Iowa and surrounding states. Most data is drawn from farm records, and that from experimental work has been adjusted to reflect farm conditions. These adjustments, and any figures estimated where data was not available, have been made with the assistance of persons familiar with the enterprises. These experts have also reviewed the farm record data used.*

Estimates used are believed to be representative of resource requirements and production that actually could be expected from enterprises of sufficient size to use resources efficiently. Yet they remain estimates. Limitations on the results are due to the data used. Most questionable are the labor requirements and distribution for multiple hog systems. Here no data was available and data for two litter enterprises had to be adapted. Further work on compiling basic information

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*Data was reviewed by the following persons on the Iowa State College staff: beef data--Prof. C. C. Culbertson, Animal Husbandry; swine data--Prof. William Zmolek and Prof. Duane Acker, Animal Husbandry; and crops and fertilization--Prof. W. D. Shrader, Agronomy.

in all areas will be most welcomed by those engaged in farm planning studies.

Footnotes to the tables in this section indicate specific sources of data used. These and the estimated items should follow from the sets of practices defined in Appendix A.

Table 23. Estimated average crop yields[a] for selected rotations,[b] soils, levels of management, and fertilization rates[c]

Soil, rotation, and management	Yields of fertilization									
	1st year corn		Soybeans		2nd year corn		Oats		1st year meadow	2nd year meadow
	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1 F_2	F_0 or F_1 F_2
Clarion-Webster soil										
CCOM										
Low level	56	65			48	60	36	48	1.8	2.0
Average	60	71.5			51.5	66	38	51.5	2.3	2.7
Superior	70.5	78			64.4	72	46.6	55	3.0	3.4
CSbCOM										
Low level	56	65	21	23	48	60	36	40	1.8	2.2
Average	60	70	22.5	26.5	52	66.5	40.5	47.5	2.3	2.8
Superior	69.3	75	28.2	30	65.4	73	50	55	3.0	3.4
CCSb										
Low level	45	65	20	22	40	60				
Average	49	68.5	20.5	24	42.5	64				
Superior	64.1	72	24.6	26	58.2	68				
Grundy-Haig silt loam										
CCOM										
Low level	50	55			40	50	30	35	2.0	2.3
Average	52.5	60			42.5	55	32.5	38.5	2.1	2.45
Superior	60.9	65			54	60	38.9	42	2.3	2.6
CSbCOM										
Low level	50	55	22	24	40	50	30	35	2.0	2.3
Average	52.5	60	23.5	26	42.5	55	32.5	37.5	2.1	2.45
Superior	60.9	65	27.2	28	54	60	38.1	40	2.3	2.6
CCSb										
Low level	38	50	17	20	34	48				
Average	39	55	19.5	23	34.5	53				
Superior	51.7	60	24.6	26	48.5	58				
Grundy silt loam										
CCOM										
Low level	48	55			38	50	30	35	2.0	2.3
Average	52.5	60.5			40	55	32.5	38.5	2.1	2.45
Superior	62.4	66			52.6	60	38.9	42	2.3	2.6

[a] Yield data provided by W. D. Shrader, Agronomy Department, Iowa State College.

[b] In rotation abbreviations, C represents corn, Sb is soybeans, O stands for oats, and M means meadow.

[c] F_0 indicates no fertilization. It applies to low level or average managers. F_1 is intermediate fertilization rate applying to superior managers. Table 24 gives amounts of nutrients used.

Table 23. (Continued)

Soil, rotation, and management	Yields and fertilization											
	1st year corn		Soybeans		2nd year corn		Oats		1st year meadow		2nd year meadow	
	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2	F_0 or F_1	F_2
CSbCOM												
Low level	48	55	18	21	38	50	30	35	2.0	2.3		
Average	52.5	60.5	21	24.5	40	55	32.5	38.5	2.1	2.45		
Superior	62.4	66	26.6	28	52.6	60	38.9	42	2.3	2.6		
CCOMN												
Low level	50	55			45	50	30	35	2.0	2.3	1.5	1.8
Average	54	61.5			49.5	57	34	38.5	2.1	2.45	1.95	2.3
Superior	63	68			60.2	64	40.6	42	2.3	2.6	2.5	2.8
COM												
Low level	48	55					30	35	2.0	2.3		
Average	52.5	60.5					32.5	38.5	2.1	2.45		
Superior	61.6	66					38.9	42	2.3	2.6		
Shelby loam[d] (4-8% slope)												
COM												
Low level	30	40					22	30	0.8	1.5		
Average	34	44					23.5	31	0.9	1.65		
Superior	44.5	48					29.5	32	1.3	1.8		
COMM												
Low level	30	40					22	30	0.8	1.5	0.6	1.5
Average	34	45					26	32.5	0.9	1.65	0.7	1.75
Superior	45.2	50					33.4	35	1.3	1.8	1.9	2.0
CCOMM												
Low level	30	40			27	35	22	30	0.8	1.5	0.6	1.5
Average	34	45			30.5	40	23.5	31	0.9	1.65	0.7	1.75
Superior	45.2	50			41.3	45	29.5	32	1.3	1.8	1.9	2.0
Shelby loam[d] (9-14% slope)												
COM												
Low level	25	35					17	28	0.8	1.5		
Average	26.5	40					18.5	30	0.9	1.65		
Superior	38	45					26.6	32	1.3	1.8		
COMM												
Low level	28	35					20	28	0.8	1.5	0.6	1.5
Average	30	40					21	30	0.9	1.65	0.7	1.75
Superior	39.7	45					27.9	32	1.3	1.8	1.9	2.0
CCOMM												
Low level	28	35			25	30	20	25	0.8	1.5	0.6	1.5
Average	30	40			26	35	20	28.5	0.9	1.65	0.7	1.75
Superior	39.7	45			35.2	40	26.6	32	1.3	1.8	1.9	2.0

[d]These are combined into Class III land in the study. Of the Class III land, 86.4% is 9-14% slope and 13.6% is 4-8%.

Table 24. Fertilization rates: pounds per acre of available nutrients used for various soils, rotations, and rates of application

Soil unit	Rotation	Soil test at F_0[a]			Amount required for F_2 yields[b]								
					1st year corn			Soybeans			2nd year corn			Oats		
		N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Clarion-Webster	CCOM	L+	L-	M	10	60	20				30	30	20	10	60	20
	CSbCOM	L+	L-	M	10	60	20	0	30	0	30	30	20	10	60	20
	CCSb	L+	L-	M	45	60	20	0	30	0	50	30	20			
Grundy-Haig (0-1%)	CCOM	M-	L+	M	20	25	15				40	25	15	10	35	0
	CSbCOM	M-	L+	M	20	25	15	0	10	0	40	25	15	10	35	0
	CCSb	M-	L+	M	50	25	15	0	10	0	60	25	15			
Grundy silt loam (2-5%)	CCOM	L+	L+	M+	20	25	10				45	25	10	10	35	0
	CSbCOM	L+	L+	M+	20	25	10	0	10	0	45	25	10	10	35	0
	CCOMM	L+	L+	M+	10	25	10				30	25	10	10	45	0
	COM	L+	L+	M+	10	25	10							10	35	0
Shelby loam (4-8% and 9-14%)	COM	L	VL+	L+	40	45	45							20	60	25
	COMM	L	VL+	L+	30	45	45							20	80	50
	CCOMM	L	VL+	L+	30	45	45				60	45	45	20	80	50

[a] F_0 indicates no fertilization.

[b] F_1 yields require 1/2 this rate.

Table 25. Beef cow enterprises: basic data for two systems at three management levels

Item	Sell calves			Feed out calves		
	Low level	Average	Superior	Low level	Average	Superior
Marketing month	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.
Market weight of calf or steer (lbs.)	400	415	430	976	1027	1078
Calf crop (%)	70	80	90	70	80	90
Weight sold per unit						
Calf or steer	233.3	276.7	322.5	569.3	684.7	808.5
Cow	167	175	183	167	175	183
Annual cash expense						
Protein	$	$	$	$ 8.14	$ 9.20	$ 10.46
Power[a]	1.77	1.77	1.77	4.42	4.42	4.42
Equipment replacement[a]	4.26	4.26	4.26	7.50	7.50	7.50
Hay harvest	5.32	5.32	5.32	9.59	9.59	9.59
Breeding costs[b]	3.50	5.20	7.00	3.50	5.20	7.00
Hauling	1.47	1.53	1.59	2.97	3.12	3.28
Misc., Vet.[a]	6.74	6.74	6.74	9.00	9.00	9.00
Total annual cash expense	23.06	24.82	26.68	45.12	48.03	51.25
Capital investment						
Equipment[c]	$ 7.91	$ 7.91	$ 8.46	$ 18.17	$ 23.33	$ 26.34
Breeding stock	173.25	181.90	190.58	173.25	181.90	190.58
Feed fed						
Corn equivalent (bu.)	0	0	0	39.76	45.44	51.10
Supplement (lbs.)	0	0	0	171.5	195.8	220.3
Hay	1.2	1.2	1.2	1.876	1.972	2.068
Pasture (AUD)[d]	267	267	267	293.6	297.4	301.2

[a]Mueller (12).

[b]Judgement estimate.

[c]Equipment investment costs are detailed in Table 27.

[d]Animal unit days.

Table 26. Cattle feeding enterprises: basic data for four systems at three management levels

Item	Calves						Yearlings			
	Drylot			Pasture			Long fed			Short fed
	Low	Ave.	Sup.	Low	Ave.	Sup.	Low	Ave.	Sup.	Sup.
Purchase month	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct.	Oct., April
Market month	Sept.	Sept.	Sept.	Oct.	Oct.	Oct.	July	July	July	March, Sept.
Purchase weight	400	400	400	400	400	400	650	650	650	700
Market weight	978	1012	1046	976	1012	1048	1082	1109	1136	1040
Average daily gain	1.7	1.8	1.9	1.6	1.7	1.8	1.6	1.7	1.8	2.0
Days on farm	340	340	340	360	360	360	270	270	270	170
Death loss (%)	3	3	3	3	3	3	1.5	1.5	1.5	0.75
Feed fed										
Corn (bu.)	66.3	66.3	66.3	56.8	56.8	56.8	54.2	54.2	54.2	80.2
Supplement (lbs.)	287.6	287.6	287.6	244.8	244.8	244.8	220.3	220.3	220.3	326.4
Hay (tons)	0.71	0.71	0.71	0.96	0.96	0.96	1.26	1.26	1.26	1.94
Pasture (AUD)[a]	0	0	0	38	38	38	0	0	0	0
Annual cash expense										
Protein	$13.69	$13.69	$13.69	$11.57	$11.57	$11.57	$10.46	$10.46	$10.46	$15.50
Power and machine[b]	2.45	2.45	2.45	2.45	2.45	2.45	2.30	2.30	2.30	3.40
Equipment replacement	3.24	3.24	3.24	3.24	3.24	3.24	2.62	2.62	2.62	3.68
Hay harvest	3.13	3.13	3.13	4.27	4.27	4.27	5.58	5.58	5.58	8.60
Misc.[b]	2.26	2.26	2.26	2.26	2.26	2.26	1.84	1.84	1.84	2.72
Death loss[c]	2.46	2.46	2.46	2.46	2.46	2.46	1.84	1.84	1.84	1.93
Feeder stock	82.08	82.08	82.08	82.08	82.08	82.08	122.78	122.78	122.78	135.17
Hauling	3.58	3.67	3.76	3.58	3.67	3.76	4.48	4.56	4.64	9.05
Investment in equipment[d]	10.25	14.67	17.65	10.25	15.42	18.38	10.25	14.67	17.65	17.65

[a]Animal unit days.

[b]Mueller (12).

[c]Assumes 1.03 animals purchased per animal marketed.

[d]Equipment investment costs are detailed in Table 27.

Table 27. Per unit equipment cost for cattle for three management levels

	Feeder cattle			Beef cows		
	Superior	Average	Low level	Superior	Average	Low level
Feed bunk	$ 2.18	$ 2.18	$ 2.18	$	$	$
Water tank	3.08	3.08	3.08	3.08	3.08	3.08
Tank heater	2.58	2.58	2.58	2.58	2.58	2.58
Hay rack	1.50	1.50	1.50	1.50	1.50	1.50
Oiler, back scratch	.55	.55	.55	.55		
Electric fence controller	.75[a]	.75[a]		.75	.75	.75
Feed handling equipment	.36	.36	.36			
Feedlot paving	7.38	4.42				
Total on pasture	18.38	15.42	10.25	8.46	7.91	7.91
Total on drylot	17.65	14.67	10.25			

[a]This item used for pasture system only. All item costs except concrete equipment purchased and valued at 1/2 of new price. Prices were obtained from local suppliers.

Table 28. One litter system: basic data where one unit equals one litter

	Management		
	Low level	Average	Superior
Farrowing date	May	May	May
Pigs weaned per unit	6.00	7.30	9.00
Death loss after weaning	.09	.10	.12
Replacement gilts kept	1.08	1.08	1.08
Hogs marketed per unit	4.83	6.12	7.80
Selling weight of pigs	240.00	240.00	240.00
Pigs sold (total cwt.)	11.59	14.69	18.72
Selling month	Dec.	Dec.	Dec.
Average selling price ($)	14.46	14.86	15.26
Gross from market hogs ($)	167.59	218.44	285.36
Selling weight of sow	350.00	350.00	350.00
Selling month	July	Sept.	Aug.
Selling price ($)	14.62	14.58	15.01
Gross from sow ($)	51.17	51.03	52.54
Gross revenue per unit ($)	218.76	269.47	337.90
Feed fed			
Corn equivalent (bu.)	91.097	93.282	98.211
Supplement (cwt.)	5.216	6.365	8.051
Hay (tons)	.00	.018	.025
Pasture days	25.498	29.380	37.440
Annual cash expense ($)			
Supplement	33.90	41.37	52.33
Boar charge	1.50	2.50	4.00
Power and machinery[a]	5.88	5.88	5.88
Equipment use[a]	5.80	5.80	5.80
Hauling	.79	1.00	1.27
Vet., electricity, misc.[a]	3.71	4.70	5.99
Total annual cash expense ($)	51.58	61.25	75.27
Capital investment ($)			
Gilt	34.70	35.66	36.62
Equipment	11.74	20.87	25.12
Capital coefficient ($)	98.02	117.78	137.01
Net return per unit ($)	167.18	208.22	262.63
Building space	.75	.75	.75
Cost of purchased building[c]	63.75	63.75	63.75
Capital coefficient, with building purchased ($)	161.77	181.53	200.76

[a]Hardin et al. (4).

[b]Includes fencing, concrete floors, tanks, feeders, and other equipment. Data was obtained from Mueller (12), McKenzie et al. (9), Hardin et al. (4), and Jedele (8).

[c]Costs are detailed in Table 34.

Table 29. Two litter system: basic data where one unit equals two litters

	Management		
	Low level	Average	Superior
Farrowing dates	April, Oct.	Mar., Sept.	Feb., Aug.
Pigs weaned per unit	12.0	14.6	18.0
Death loss after weaning	.18	.20	.23
Replacement gilts kept[a]	1.08	.83	.48
Pigs sold per unit	10.74	13.57	17.45
Selling weight of hogs	240.00	230.00	220.00
Total weight of pigs sold (cwt.)	25.776	31.211	38.39
Selling months	Nov., May	Sept., Mar.	July, Jan.
Average selling price[b] ($)	15.52	16.44	17.19
Gross revenue from market hogs ($)	400.06	513.08	677.23
Selling weight of sow	350.00	400.00	450.00
Selling months	July, Jan.	June, Dec.	April, Oct.
Average price ($)	14.12	13.95	14.26
Sow sold[a] (lbs.)	350.00	300.00	180.00
Gross revenue from sow ($)	49.42	41.85	25.67
Gross revenue per unit ($)	449.48	554.93	702.90
Feed fed			
Corn equivalent (bu.)	206.916	202.824	213.888
Supplement (cwt.)	12.642	14.601	20.237
Hay (tons)	.000	.031	.054
Pasture days	28.380	31.300	36.480
Annual cash expense ($)			
Supplement	82.17	94.91	131.54
Boar charge	2.50	4.50	7.00
Power and machinery[c]	9.36	9.36	9.36
Equipment use[d]	11.08	13.42	16.51
Hauling	1.75	2.12	2.61
Vet., electricity, misc.[d]	10.31	12.48	15.36
Total annual cash expense ($)	117.17	136.79	182.38
Capital investment ($)			
Breeding females	38.94	45.43	50.62
Equipment[e]	13.05	39.89	57.00
Capital coefficient ($)	169.16	222.11	290.00
Net return per unit ($)	332.31	418.14	520.52
Building space (units)	1	1	1
Cost of purchased building[e] ($)	85.00	85.00	85.00
Capital coefficient, with building purchased ($)	254.16	307.11	375.00

[a]8% allowance for nonbreeders, etc. Replaces sows after 2, 3, and 5 litters, respectively.

[b]Arithmetic average price for two selling months plus or minus $0.40 per cwt. management differential.

[c]Mueller (12).

[d]Hardin et al. (4).

[e]Detailed breakdown of costs is in Table 34.

Table 30. Four litter system: basic data where one unit equals two sows and four litters

	Management	
	Average	Superior
Farrowing months	Dec., Feb., June, Aug.	Jan., Mar., July, Sept.
Pigs weaned per unit	29.30	36.00
Death loss after weaning	.40	.47
Replacement gilts kept	1.50	0.96
Hogs marketed per unit	27.40	34.57
Selling weight of pigs	230.00	220.00
Pigs sold (total cwt.)	63.02	76.05
Selling months	June, Aug., Dec., Feb.	June, Aug., Dec., Feb.
Average selling price ($)	16.70	17.10
Gross return from market hogs ($)	1052.43	1300.52
Selling weight of sow	400.00	450.00
Selling months	March, May, Sept., Nov.	March, May, Sept., Nov.
Average price ($)	14.19	14.19
Sow sold (lbs.)	573.00	400.00
Gross revenue from sow ($)	81.31	56.76
Gross revenue per unit ($)	1133.74	1357.28
Feed fed		
Corn equivalent (bu.)	408.400	423.700
Supplement (cwt.)	32.140	43.348
Hay (tons)	.101	.103
Pasture days	.000	.000
Annual cash expense ($)		
Supplement	208.91	281.76
Boar charge	5.00	10.00
Power and machinery	25.21	30.42
Equipment use	27.10	32.70
Hauling	4.67	5.44
Vet., electricity, etc.	25.21	30.42
Total annual cash expense ($)	296.10	390.74
Capital investment ($)		
Breeding females	92.24	105.00
Equipment and buildings (partial)[a]	296.59	318.06
Capital coefficient, limited building purchase ($)	684.93	813.80
Net return per unit ($)	837.64	966.54
Building space, grow-fatten[a]	117.50	150.00
Capital coefficient, complete purchase ($)	802.43	963.80

[a]Details are in Table 34.

Table 31. Six litter system: basic data where one unit equals three sows and six litters

	Management Superior
Farrowing dates	Jan., Mar., May, July, Sept., Nov.
Pigs weaned per unit	54.00
Death loss after weaning	.70
Replacement gilts kept	1.30
Pigs sold per unit	52.00
Selling weight	220.00
Pigs sold (cwt.)	114.40
Selling months	June, Aug., Oct., Dec., Feb., Apr.
Average price received	16.88
Gross revenue from market hogs ($)	1931.07
Selling weight of sow	450.00
Selling months	Apr., June, Aug., Oct., Dec., Feb.
Average price ($)	14.25
Sow sold (lbs.)	360.00
Gross revenue from sow	51.30
Gross revenue per unit ($)	1982.37
Feed fed	
Corn equivalent (bu.)	637.200
Supplement (cwt.)	65.210
Hay (tons)	.154
Pasture days	.000
Annual cash expense ($)	
Protein	423.86
Boar charge	10.00
Power and machinery	45.76
Equipment use	49.19
Hauling	7.78
Vet., electricity, etc.	45.76
Total annual cash expense ($)	582.35
Capital investment ($)	
Breeding females	157.50
Equipment and buildings[a]	367.15
Capital coefficient partial building purchase ($)	1107.00
Net return ($)	1400.02
Purchase of building space for growing-fattening ($)	150.00
Capital coefficient, complete building purchase ($)	1257.00

[a]Details are in Table 34.

Table 32. Basic labor requirements for crops and livestock per unit produced[a]

Use	Management		
	Low level	Average	Superior
Corn following meadow	6.880	6.707	6.897
Corn following soybeans	7.280	7.107	7.297
Corn following corn	7.680	7.507	7.317
Oats	3.020	3.020	3.430
Soybeans	5.480	5.820	6.230
Beef cow, sell calf	17.900	17.900	17.900
Beef cow, feed out calf	36.750	36.750	36.750
Pasture fed calves	17.776	17.776	17.776
Drylot fed calves	18.410	18.410	18.410
Long fed yearlings	20.900	20.900	20.900
Short fed yearlings	27.950 13.975	27.950	27.950
One litter hog system	19.090	19.090	19.090
Two litter hog system	39.160	39.160	39.160
Four litter hog system	77.570	77.570	77.570
Six litter hog system	116.690	116.690	116.690

[a]A unit equals one acre of crop, one cow and calf, one feeder steer, or one, two, or three sows farrowing per year. Short fed yearling includes two head. Data was developed from Heady et al. (6), Mueller (12), and estimates of tractor hours required to complete selected crop growing and harvesting operations.

Table 33. Seasonal distribution of labor requirements in percentages by periods[a]

Use	Dec.-Jan.-Feb.	March-April	May-June	July-Aug.	Sept.-Oct.-Nov.
Corn	0.4	17.1	44.4	4.8	33.3
Oats	9.4	65.8	18.8	6.0	.0
Soybeans	0.7	47.3	46.1	3.3	2.6
Beef cow, sell calf	24.5	16.6	19.3	17.4	22.2
Beef cow, feed out calf	20.6	12.3	23.8	22.7	20.6
Pasture fed calves	16.3	12.9	29.3	29.0	12.5
Drylot calves	18.0	8.7	30.1	29.6	13.5
Long fed yearlings	30.1	20.1	23.3	8.2	18.2
Short fed yearlings	22.5	15.0	18.7	18.1	25.7
One litter hog system	22.8	15.8	19.5	17.4	24.5
Two litter hog system					
Low level management	21.7	18.5	19.9	14.4	25.5
Average management	22.5	22.1	16.0	14.6	24.8
Superior management	26.2	19.9	14.4	17.1	22.4
Four litter hog system					
Average management	28.4	17.1	15.8	16.3	22.4
Superior management	28.6	15.3	16.3	15.9	23.9
Six litter hog system					
Superior management	24.9	17.9	17.5	16.2	23.5

[a]Source: R. A. Hinton, Urbana, Illinois, Univ. of Illinois. Data on direct labor on northern Illinois hog and feeder cattle farms in 1956. Private communication. 1958.

Table 34. Per unit equipment cost for hogs for three management levels

Item	One litter			Two litter			Four litter		Six litter
	Sup. $	Ave. $	Low $	Sup. $	Ave. $	Low $	Sup. $	Ave. $	~~Low~~ Sup $
Scoop or wagon	.375	.375	.375	.375	.375	.375	.375	.375	.375
Castrating knife	.500	.500	---	.500	.500	---	.500	.500	.500
Pitchforks	.670	.670	.670	.670	.670	.670	.670	.670	.670
Pails	.500	.500	.500	.500	.500	.500	.500	.500	.500
Feed pans	2.080	---	---	2.080	---	---	1.666	1.666	1.666
Troughs	1.750	1.750	3.000	1.750	1.750	3.000	---	---	---
Self feeders	22.500	18.000	---	22.500	18.000	---	32.920	24.690	32.920
Tank heater	---	---	---	.625	.625	.625	---	---	---
Water tank or waterers	2.925	2.925	2.925	2.925	2.925	2.925	31.250	27.080	31.250
Pasture sunshade	3.333	3.333	3.333	3.333	3.333	3.333	---	---	---
Water pipe or wagon	2.925	2.925	2.925	2.925	2.925	2.925	6.333	6.333	6.333
Electric installations							14.580	14.580	14.580
Fencing	3.750	3.750	3.750	3.750	3.750	3.750	2.822	2.822	2.822
Steel posts or wood posts	3.863	3.863	3.863	3.863	3.863	3.863	1.834	1.834	1.834
Gate	1.600	1.600	1.600	1.600	1.600	1.600	3.200	3.200	3.200
Creep feeders	1.250	---	---	1.250	1.250	---	2.983	1.998	2.983
Heat lamps	---	---	---	2.000	2.000	2.000	2.000	2.000	2.000
Scale	.417	---	---	.417	---	---	.417	.417	.417
Ear notcher	.250	---	---	.250	---	---	.250	.250	.250
Sprayer	1.000	1.000	---	1.000	---	---	1.000	1.000	1.000
Ringer	.209	.209	.209	.209	.209	.209	.209	.209	.209
Gate, panel, crater	.333	.333	.333	.333	.333	.333	1.875	1.500	1.875
Total new cost	50.230	41.733	23.483	52.855	44.608	26.808	105.384	91.624	105.384
Half new cost of equipment[a]				26.427	22.304	---	52.692	45.812	52.692
Paving				24.570	12.790		75.000	66.000	75.000
Gravel fill				6.000	4.800		21.900	18.000	21.900
Total without buildings	25.115	20.866	11.742	56.997	39.894	13.054			
Cost of complete building[b]	63.750	63.750	63.750	85.000	85.000	85.000			
Barn and shed remodeling for growing-fattening							2.000	2.000	2.000
Fans for summer							8.131	6.439	12.220
Purchase of farrowing house, new							137.500	137.500	137.500
Nursing facilities, new							---	---	45.000
Sow shelter (1/2 new price)							20.840	20.840	20.840
Total partial building purchase							318.063	296.591	367.152
Purchase of growing-fattening facility							150.000	117.500	150.000
Total complete building purchase	88.865	84.616	75.492	141.997	124.894	98.054	468.063	414.091	517.152

[a]Equipment prices are local.

[b]Building cost is based on McKenzie et al (9) and Jedele (8).

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